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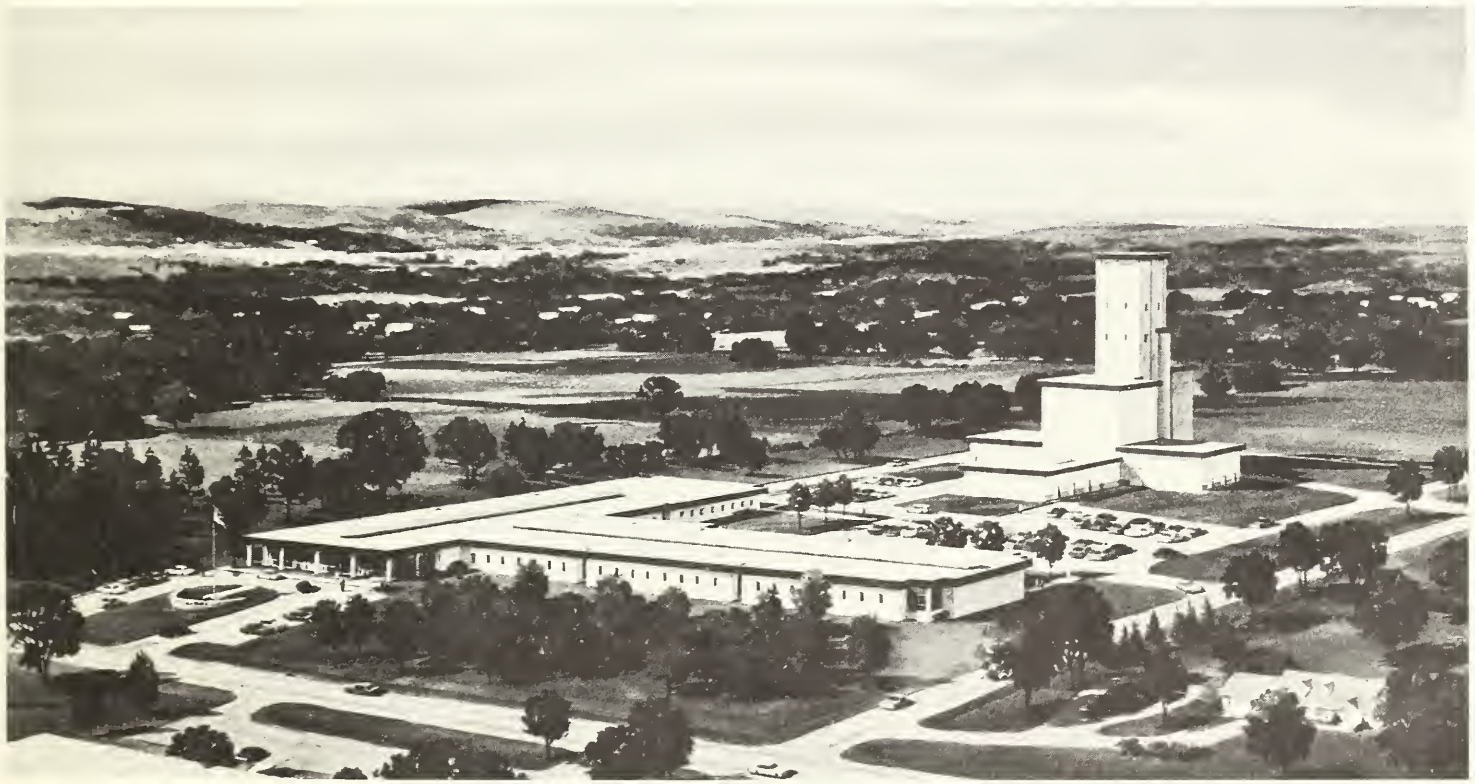

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PREFACE

This report covers activities and accomplishments of the U.S. Grain Marketing Research Laboratory (USGMRL), Agricultural Research Service (ARS), U.S. Department of Agriculture (USDA), from October 1, 1982, to December 31, 1983. We continued to manage our shrinking resources economically while selecting those areas of research with maximum impact upon our regional, national, and international grain marketing interests. Both basic and applied research have been conducted in keeping with our mission to address problems and opportunities utilizing the unique multidisciplinary capabilities among the personnel in the Laboratory. The keywords in the research programs have been cooperation and teamwork; it is axiomatic that progress is made through creative contributions of each person toward common goals.

We speak of cooperation not only among personnel within the Laboratory but also with researchers in other laboratories, both within and outside USDA. Many collaborative efforts have been carried on with various departments of Kansas State University (KSU), such as Grain Science and Industry, Agronomy, Entomology, Biochemistry, Biology, Engineering, Animal Science, Veterinary Science, Chemistry, and Plant Pathology. Collaborative studies have also been carried out with such technical projects as NC-151 (Marketing and Delivery of Quality Cereals and Oilseeds in Domestic and Foreign Markets) and S-135 (Microbial Control of Insects).

Close cooperative communication has also been maintained with personnel of action-regulatory agencies within USDA such as the Federal Grain Inspection Service (FGIS), Food and Drug Administration (FDA), Animal and Plant Health Inspection Service (APHIS), Foreign Agricultural Service (FAS), Agricultural Stabilization and Conservation Service (ASCS), and Economic Research Service (ERS). Liaison has also been maintained with laboratory personnel within ARS including those of the Western and Northern Regional Research Centers, the Stored Product Insect Research and Development Laboratory, and the Soft Wheat, Hard Red Spring, and Durum Wheat and Western Wheat Quality Laboratories. We have also coordinated efforts with various institutes, trade associations, and individual companies interested in and concerned with all phases of grain marketing. These represent a wide geographical distribution and include, among many others, the American Institute of Baking, U.S. Wheat Associates, various State wheat commissions, and the National Grain and Feed Association.

The collaborative and cooperative interactions are the direct result of the demonstrated creativity and accomplishments of scientists of the Laboratory and their support personnel. Their recent advances are tabulated in the form of scientific,

technical, and popular articles, publications, and oral presentations listed in this report. Recent progress in grain marketing research is described in this report. Highlights of this progress are as follows.

We have compared the role of proteins, starch, and pentosans in the formation of wheat, wheat-rye, and rye bread. In white wheat flour doughs, structure is based primarily on the formation of a protein matrix. In the bread, interaction between protein and starch takes place. The major contributor to the structure of rye meal bread is starch. The cementing layer in barley that causes hull-caryopsis adherence was investigated using electron microscopy and cytochemistry. The cement has a distinct morphology.

Lysine scores for triticale grains were intermediate between those of their parental wheats and rye; milling reduced contents of several amino acids, including lysine. Whereas peanut oil and fat were equally effective in increasing loaf volume, bread baked with fat had significantly superior crumb characteristics. Diacetyl tartaric acid ester glycerides were more effective than lecithin in increasing loaf volume and improving crumb characteristics. Polar wheat flour lipids had an intermediate effect. Baking scores and softness retention, generally, were positively related to loaf volume. It is possible to produce quality toast bread (with regard to loaf volume, crumb grain and texture, crumb elasticity, and softness retention) that compares with German toast bread baked with 5% fat by using a combination of 2% vegetable oil and 0.3% emulsifier.

Solubility parameter values of extractants were highly correlated with the amounts of total lipids, phospholipids, and glycolipids extracted from flours with three moisture contents. There was no selective binding between flour proteins and specific polar lipids. Digalactosyldiglycerides (DGDG) showed a clear-cut breaking point in irreversible restoration of breadmaking characteristics. The significant role of polar lipids to breadmaking, resulting primarily from the contribution of DGDG, was confirmed.

A new procedure for specific determination of beta-amylase in cereals utilizes a commercially available colorimetric substrate. The results are linear with beta-amylase over a wide range of activity and are unaffected by alpha-amylase.

Wheat hardness characteristics were more affected by kernel size in shrunken kernels than in plump kernels. The percentage of sprouted kernels did not affect the hardness values of commercial samples. Wheat hardness was unaffected by protein

contents. Growth conditions had a small effect on wheat hardness. Three methods of corn hardness determination were highly correlated and were found to be equally sensitive and useful in routine analyses.

Deoxynivalenol (DON) was found to be the only known mycotoxin in scabby wheat. An improved HPLC method was developed to determine DON. None of the cleaning methods tested completely removed scab from wheat; all fractions from milling of scab-infected soft and hard wheats contained DON. Baking of bread did not destroy DON. Swine showed no signs of sickness from eating DON contaminated diets but they began refusing feed when DON exceeded about 1 ppm. No DON was detected in tissues of swine that were withdrawn from feed for 12 hours before slaughter. The fungus in scabby wheat is an aggressive invader that destroys starch granules, storage proteins, and cell walls. Fungal hyphae are distributed throughout the entire kernel, mainly in aleurone and pericarp tissues. Ergosterol, ergosta-4,6,8(14),22-tetraen-3-one, ergosterol peroxide, and chitin are present in ergoty cereal grains. Ergot contamination increases the ergosterol content significantly more than the chitin content of the grain.

The cuticle of the red flour beetle mutant is black because of a deficiency of the nonprotein amino acid, 3-alanine. In the wild-type red strain, 3-alanine is conjugated with dopamine, to form N-3-alanyldopamine, a catecholamine oxidized for cuticular tanning. The absence of 3-alanine permits an overproduction of dopamine which is a precursor of the black pigment melanin. The results provide new information on the genetic regulation of cuticle pigmentation in insects.

Specific catecholamines are selectively incorporated into various regions of the insect exoskeleton for stabilization and pigmentation. N-Acetyldopamine predominates in hard, colorless cuticle of larval head capsule and in wing and abdominal tergite of adult Manduca sexta. N-3-Alanyldopamine is the major catecholamine in brown pupal cuticle, hard, dark larval mandible and thin, soft larval abdominal cuticle. Hemolymph is the storage site for catecholamines where they occur primarily as ring hydroxyl conjugates of glucose.

New regulatory factors for insect cuticle sclerotization and pigmentation have been identified. The tanning enzyme tyrosinase catalyzes multiple steps in the Mason-Raper pathway for catecholamine oxidation. It hydroxylates tyrosine and oxidizes both dopamine and dihydroxyindole. Tyrosinase is synthesized as a proenzyme, stored in hemolymph, and activated by a serine protease in the cuticle. A new metabolite of tyrosine, N-3-alanylnorepinephrine, was isolated from newly

ecdysed cuticle. A new enzyme, dopaquinone imine conversion factor, which facilitates formation of dihydroxyindole, was partially pacified from pharate pupal cuticle. The results provide new insights into the metabolic regulation of cuticle morphogenesis in insects.

A simple ketone and ester suppress populations of stored grain beetles. A survey of alkyl ketones and derivatives for toxicity to stored-product insects reveals that 2-tridecanone was repellent to weevil species and also exhibited ovicidal activity. 2-Tridecanyl acetate was found acutely toxic to stored grain Coleoptera.

Methyl ether derivatives of ascorbic acid were synthesized and their growth promoting activity compared to the natural vitamin. The 2- and 3-methyl ethers were only marginally active in the guinea pig and tobacco hornworm. 1-Methyl ascorbate has strong antiscorbatic activity in the guinea pig.

Multiple sites for insect neuropeptide production have been identified in nervous tissue. The insect brain and associated tissues are rich sources of numerous neuropeptides. Over 170 cells have been characterized according to neuropeptide type with enkephalin-containing cells the most frequent followed by insulin-, endorphin-, glucagon- and gastrin-containing cells.

UC-76212, UC-76214, and UC-76220 were evaluated as carbaryl synergists against the lesser grain borer (LGB), rice weevil (RW) and red flour beetle (RFB) by the filter-paper exposure method. All were effective against the carbaryl-tolerant species (RW and RFB) but none were active against the carbaryl-sensitive species (LGB). The three compounds were active against RW and RFB, even at doses ten-fold or more below the carbaryl dose. The greatest activity of any of the synergists was expressed by UC-76220 against RFB. This substance was an effective synergist, even at doses 1,000-fold below the carbaryl dose. The standard carbaryl synergist, piperonyl butoxide, was ineffective against all three species.

Two alleles were resolved at the malathion-resistance locus on chromosome 6 of the red flour beetle. One allele (Rmal-1) is completely dominant, confers low-level resistance, and is common in midwestern strains of the red flour beetle. Another (Rmal-2) is incompletely dominant, confers high-level resistance, and occurs in strains collected in North Carolina and Georgia. Modifying genes had a small effect on the expression of Rmal-2 and no effect on the degree of dominance of this allele.

A high yield of chromosome rearrangements causing partial sterility were recovered from gamma-irradiated red flour beetles. At least five of the rearrangements involve either chromosome 4 or the Y chromosome. Such rearrangements are useful for basic studies on population biology, evolution, and speciation, and for applied studies on the genetic control of pest populations.

The recent national attention that has been focused on increased grain storage in the United States has suggested the need for indepth studies of insect infestations in onfarm storage. A scientist has been added to the Laboratory staff to study bin ecology. The quantitative and systematic study of factors affecting pest populations will provide information needed for rational development of integrated pest management systems.

The effect of wheat class, wheat cultivar, and wheat protein on the degradation of ^{14}C-malathion was investigated. Hard wheats contained higher quantities of radiocarbon in extraction phases generally associated with insecticide metabolism than did soft wheats such as winter white and club wheat. Hard red spring and durum wheats contained relatively large quantities of unextractable residues, while hard red winter wheat contained relatively large quantities of ^{14}C-volative compounds. The low protein sample of hard red winter wheat contained significantly lower quantities of unextractable residues and significantly higher quantities of ^{14}C-volatile residues than the sample with high protein content.

The microbial insecticide Bacillus thuringiensis is selective towards certain insects (ordinarily Lepidoptera), and the spores and crystals exert their own degree of selectivity. Crystals are toxic for the almond moth, yet the Indianmeal moth requires both spores and crystals for adequate control. The spore initiates secondary infection in complete control of the Indianmeal moth. We continue to investigate the mode of action of B. thuringiensis with insect larvae and with cultured insect tissue to better understand the events associated with toxicity.

We concluded a 3-year pilot test of the effectiveness of Bacillus thuringiensis for controlling Indianmeal moth in farm stored grain. Dust and wettable powder formulations were equally effective, and reduced water volumes were acceptable for application of the wettable powder. Overall, the treatments reduced moth populations by about 50% and in some areas by as much as 87%.

We have continued our research efforts in grain-storage aeration studies. We have demonstrated a complete control of grain heating problems with a controlled grain aeration system.

We are making progress toward developing computerized systems to simplify and automate the control of grain storage and handling facilities. The techniques may also be applied to the classification of grains such as rice and wheat.

We have established a data base for grain-dust explosibility. Using corn, wheat, and grain sorghum dust, and cornstarch, we have developed and standardized dust-explosion tests related to the deflagration characteristics of dust--that is, power, (maximum pressure, rate of pressure rise) and propagation (explosive limits, inert, ignition).

We have developed a new method of rapidly measuring grain dustiness based on the analysis of residual dustiness in a small grain sample. This method enabled us to effectively determine the dust emission of grain during handling.

The effect on the resolution and clarity of gliadin bands on temperatures (4°, 7°, 10°, and 21°C) of electrophoresis and the form of the lactate buffer (sodium or aluminum) was studied. Optimal results were found with an aluminum lactate buffer system at 7° to 10°C for 6 1/2 hours.

A method for analyzing protein hydrolysates at the picomole (10^{-12}) level was developed. The effects of two thiol reagents, ethanethiol and 2-mercaptoethanol, were described, and ethanethiol was preferable.

Ascorbic acid (vitamin C) is an important chemical in the baking industry because it acts as a chemical oxidant and can replace other chemicals, such as potassium bromate, that are to some extent, traditionally used and in some countries banned. Since optimized bread loaves are obtained over a range of amounts of ascorbic acid, less test-baking is required to conduct wheat-variety and other types of research.

Methods have been developed for using HPLC to characterize purothionin proteins and proteolytic peptides made from purothionins. These methods have made it possible, for the first time, to determine the amino acid sequences of purothionins from wheat diploid ancestor species.

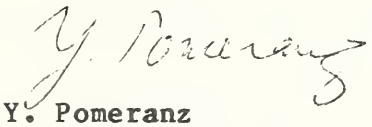
The applicability of research findings to the marketplace is often influenced by the economics involved. Cost-benefit ratio can be a major consideration in research, even during the planning stage. The presence at the USGMRL of two research

economists who are members of our sister agency, the ERS, provides us with consulting expertise that adds another dimension and perspective to our efforts.

Our scientists continue to be recognized for their research excellence through grants and awards. The USDA Competitive Grants Office of USDA gave a grant for the study of insect control through chitin-degrading enzymes and the National Science Foundation approved one on the regulation of tyrosine metabolism for cuticle tanning (cooperatively with the KSU Department of Entomology). We also have a USDA Competitive Grant on the mechanism of protein biosynthesis in wheat.

The high scientific standing of many of our employees is demonstrated through requests to serve in many capacities. Our scientists serve on editorial boards of highly regarded technical journals; they organize and participate in symposia, workshops, and short courses; they deliver invited lectures, edit books and monographs,and participate in research planning sessions; they serve on personnel evaluation committees; and they are involved in societal affairs in many ways.

The Laboratory was favored by hundreds of visitors from most States of the Nation and more than 50 foreign countries. Government officials, trade representatives, scientists, educators, students, farmers, millers, and bakers were among the visitors. Space does not permit the listing of individuals or groups, except to indicate that we were happy to cooperate with many groups, including the KSU Food and Feed Grain Institute and International Grains Program, the Kansas Wheat Commission, the U.S. Wheat Associates, and the Group for Assistance on Systems Relating to Grain After Harvest.



Y. Pomeranz
Director, USGMRL

CONTENTS

GRAIN STRUCTURE, COMPOSITION, AND CHARACTERIZATION UNIT

Scientists in this unit conduct investigations to (1) determine relation of grain structure to storage, handling, and utilization; (2) identify composition of cereal grains in relation to storage, handling, utilization, and nutritive value; (3) develop the use of enzymes to determine composition, structure, storability, and damage during handling of cereal grains; (4) develop tests on grain quality for use in plant-breeding programs, in quality control during processing and storage, and by action and regulatory agencies during marketing; and (5) identify, control, and eliminate mycotoxins from cereal grains.

Grain Structure

We study cereal grains and processed grain products using various microscopic techniques including light and scanning and transmission electron microscopy. These studies are designed to correlate grain structure with market quality investigations conducted in other research units in the Laboratory.

Wheat, Wheat-Rye, and Rye Dough and Bread Studied by Scanning Electron Microscopy.--Three types of bread (100% white wheat flour, 60% wheat:40% rye flours, and 90% rye meal:10% rye flour) were examined by scanning electron microscopy along with appropriate samples drawn during dough mixing, various stages of sourdough production and fermentation, and baking. In white wheat flour doughs, structure was based primarily on formation of a protein matrix. Large starch granules and especially "stringing" of small starch granules contribute to dough structure in white wheat flour systems. In the bread, interaction between protein and swollen starch (mainly large granules) takes place. Much of the starch is modified, but, in some "protected" crumb and crust areas (inside vacuoles), little modification, especially of small starch granules, was observed. In the mixed wheat:rye system, some contribution, apparently, is derived also from gumlike substances and from modifications of gluten and starch by organic acids. In rye meal systems, gum materials facilitate stringing of small starch granules and their adherence to large granules. Whereas in white wheat or mixed wheat-rye systems, pericarp-aleurone particles are part of the problem, in the rye meal system they are part of the solution of providing a coherent and continuous dough or bread structure. The major contributor to rye meal bread structure is modified starch. The rye meal bread crust, unlike the crust of wheat and mixed wheat/rye flour bread, is coarse and affected by the presence of aleurone-pericarp-rich particles.

Structures of Wheat, Wheat-Rye, and Rye Breads.--Structures of rye-flour doughs, crumb and crust of wheat, rye-wheat, rye-flour, and rye-meal breads were examined by scanning electron microscopy. In the rye-wheat flour dough, in addition to a protein matrix, gumlike materials seemed to contribute to the

structure. In the rye meal dough, structure was based on contributions of several components, including starch aggregates, large meal chunks, aleurone-pericarp particles, and probably gumlike materials. The crumb of wheat flour bread had a fine network of protein strands and sheets enmeshing and covering, to widely differing degrees, expanding and interacting starch granules. The crumb of the rye/wheat flour bread is crumbly and fragile. Starch modification-expansion-interaction was responsible to a larger degree for crumb formation and structure in rye than in wheat bread. The modification was smaller in protected areas inside vacuoles than outside vacuoles. Fracture of freeze-dried crumb showed the interaction among starch granules themselves and a matrix or gumlike membrane and formation of vacuoles. Extent of starch modification in the crust seems related to water availability. Crumb and crust texture differed in number, size, and distribution of small-intermediate vacuoles. They were greater and more uniform in wheat than in rye and in flour than in meal-based bread.

A Microscopic Study of the Development of the Barley Cementing Layer that Causes Hull-Caryopsis Adherence.--The cementing layer in barley that causes the hull to adhere to the caryopsis was investigated using transmission electron microscopy and cytochemistry. The cementing substance appeared on the surface of the pericarp 2 days after flowering before the physical contact between the caryopsis and the hull. The cementing layer increased in thickness throughout kernel development. The substance is secreted solely by the pericarp epidermis as no cementing material is found associated with the hull until after pericarp-hull contact. Cytochemical tests for protein and carbohydrate gave negative results for the cementing layer. Thickness of the cementing layer in mature kernels is highly variable, ranging from 130 to 680 nm. The cement has a distinct morphology, being nearly electron-transparent and bearing faint lamellar striations. The junction between the hull and cement is smooth and distinct, while the junction between the cement and pericarp is very irregular. Mechanical separation of the hull from the caryopsis usually results in the cementing layer remaining attached to the pericarp.

Grain Composition

In these studies, our approach is to determine protein, lipid, mineral, and carbohydrate contents and products of their interaction among grain components as they relate to storage, handling, utilization, and nutritional value. The studies are designed to provide information on composition of cereal grains to other units in USGMRL in investigating the effects of composition on handling, storage, end uses, nutritional value, and development of quality tests.

Amino Acid Composition of Triticales, Their Parental Wheats and Rye Grains and Milled Flours.--Amino acid composition was determined in two hexaploid triticales, their parents, a stable triticale, and wheat. Tryptophan, threonine, cystine, and glycine contents of triticale grains and flours were higher than those of either parents. Four amino acids were intermediate for one triticale grain, 10 were intermediate for its milled flour, and 9 were intermediate for the other triticale grain and its flour. Milling reduced lysine, histidine, arginine, aspartic acid, threonine, glycine, alanine, and valine contents, but increased glutamic acid, proline, and methionine. The lysine scores for triticale grains and flours were intermediate between their parents. Threonine scores for the triticale grains and flours were higher than for their parents.

Toast Bread from Defatted Wheat Flour.--Toast bread was baked from nondefatted and petroleum-ether defatted flour of medium protein content and strength. The formulation included 5% peanut oil or fat, 0.2% to 0.4% diacetyltartaric acid esters (DAWE) or lecithin, 0.1% to 0.2% polar wheat flour or wheat gluten lipids, 0.55% nonpolar wheat flour or wheat gluten lipids, and combinations of 5% fat or oil and emulsifiers or wheat flour lipids. Whereas peanut oil and fat were equally effective in increasing loaf volume, bread baked with fat had significantly superior crumb characteristics. DAWE was more effective than lecithin in increasing loaf volume and improving crumb characteristics. Polar wheat flour lipids had an intermediate effect. In combinations with emulsifiers or wheat flour polar lipids, an improving interaction with oil seems to take place. The effects of surfactant (alone or in combination with 5% oil or fat) were more pronounced when added to defatted flour than when added to nondefatted flour. Increasing amounts of surfactants, within the limits used in this study, increased loaf volume and, generally, improved bread crumb characteristics. When added to defatted flour, wheat flour polar lipids were more effective and nonpolar lipids were more detrimental than corresponding lipids extracted from vital commercial gluten. The difference can be related to the composition of the extracted and fractionated lipids. Baking scores and softness retention were generally positively related to loaf volume.

Toast Bread with Oil or Fat.--Toast bread was baked with 0.3% (active matter) DAWE, lecithin, or mono-diglycerides, alone or in combination with 1%, 3%, 5%, 10% and 15% peanut oil or peanut fat. Without emulsifiers, loaf volumes were higher with 1% or 3% fat than 1% or 3% oil. Above 5% oil (but not fat) increased loaf volume more. Bread baked with 5% fat was superior in overall bread characteristics to breads baked with

any level of oil without emulsifier. In bread baked with or without added fat or oil, DAWE increased loaf volume most; the increase was accompanied by a slight reduction in crumb elasticity. The loaf volume increases from adding emulsifiers were also observed in breads baked with emulsifier-fat and emulsifier-oil combinations. DAWE affected the largest increases. Mixtures of fats and oils in combination with emulsifiers were slightly more effective in increasing loaf volume and improving overall bread characteristics than combinations of emulsifiers with either fat or oil alone. It is possible to produce quality toast bread (with regard to loaf volume, crumb grain and texture, crumb elasticity, and softness retention) that compares with toast bread baked with 5% peanut fat (the conventional method) by using a combination of about 2% vegetable oil and 0.3% emulsifier. Adding DAWE is more effective in attaining that objective than lecithin or mono-diglycerides. The loaf volume-increasing effectiveness of emulsifiers must be balanced, however, against their tendency to reduce crumb elasticity.

Solvent Solubility Parameter and Flour Moisture Effects on Lipid Extractability.--Lipids were extracted with a series of solvent systems whose solubility parameter (δ) values ranged from 7.27 to 12.92 (hexane and its aqueous azeotrope, benzene, acetone and its azeotrope, and 2-propanol and its azeotrope) from a flour with 1.2%, 7.2%, or 13.8% moisture content (MC). The extracted total lipids (TL) were fractionated into nonpolar lipids (NL) and polar lipids (PL) by silicic acid column chromatography: NL and PL were further subfractionated by thin-layer chromatography. PL were separated into glycolipids (GL) and phospholipids (PhL). TL, NL, and PL extractabilities were affected by both flour MC and by nature and composition of extractants: the overall solvent effects were substantially more pronounced than the flour MC effects. Free fatty acids and digalactosyldiglycerides (DGDG) extractabilities increased for all extractants, in general, as flour MC increased. There were significant linear relations between the δ values of extractants and the average amounts of TL, PL, GL, and PhL from flours with three MC. The high correlation ($r=0.981$) between δ and extractability of TL was primarily due to PL; extractabilities of monoglycerides (among NL) and all classes of GL and PhL were significantly (at the 0.01 level) linearly related to the δ values at all three flour MC levels. The present study indicated no selective binding between flour proteins and a specific PL class. Among PL, DGDG showed a clear-cut breaking point in irreversible restoration of breadmaking characteristics. Thus, the present study confirms the significant role of PL to breadmaking, resulting primarily from the contribution of DGDG.

Use of Enzymes

Enzymes are used to determine composition (proteins, carbohydrates, lipids, glycolipids, lipoproteins, and glycoproteins) and nutritional value of cereal grains, including availability of nutrients and their modification during handling, storage, and processing. Enzyme activity is assayed to determine grain quality at sprouting and deterioration during handling and storage. Studies are designed to provide information on the chemical composition (as determined by enzymatic methods) and on levels of specific enzymes directly related to quality. The information is used collaboratively among units at the laboratory to investigate various quality characteristics important in the marketing of grain and to develop testing methods for those quality factors. Enzymes are used to determine, selectively and specifically, trace amounts of nutrients and contaminants in mold-, insect-, or rodent-infested grain.

A New Procedure for Specific Determination of Beta-Amylase in Cereals.--This method utilizes a commercially available colorimetric substrate. The results are linear with beta-amylase over a wide range of activity. The level of beta-amylase found in a series of flours was relatively constant. Tests in which increasing amounts of a pure barley alpha-amylase were added to a constant amount of beta-amylase showed no increase in absorbance using this substrate. Under the same conditions, results from the commonly used Bernfeld assay for beta-amylase showed an increase in absorbance, verifying that this test responds to both alpha- and beta-amylase. Additional tests using a series of sprouted wheats also showed no response to alpha-amylase. This test can be done using existing instrumentation and should prove useful for plant physiology studies requiring specific determination of alpha- and beta-amylase.

Quality Tests

The information developed in the Grain Structure, Composition, and Characterization Unit, and in other units at USGMRL, is used to develop tests for evaluating end-use properties of new wheat cultivars, determining changes that occur during storage of grain, and evaluating grain in marketing channels.

The Relative Hardness of Shrunken and Sprouted Wheat.--Three methods (time to grind, particle size of ground wheat, and near-infrared reflectance of ground wheat) were used to measure hardness in plump and shrunken wheat samples and their sieved fractions in two series of commercial wheat samples that varied in percentage of sprouted kernels and in samples of four wheat cultivars germinated for various times in the laboratory. Hardness characteristics were much more affected by kernel size in shrunken kernels than in plump kernels. Generally, as kernel size decreased, grinding time and particle size of ground wheat (particle size index) increased and NIR (near infrared reflect-

ance) values decreased. The percentage of sprouted kernels did not affect consistently the hardness values of commercial samples even though the results of hardness measurements by the three methods were correlated. Hard wheats (spring and winter) mellowed as germination proceeded: time to grind increased and particle size of ground wheat decreased. No such changes were observed in soft wheats.

Corn Hardness Determination.--Breakage susceptibility and kernel hardness as measured by density, NIR, and average particle size (APS) of ground material were determined for four groups of corn samples. The groups were: isogenic pairs with regard to hardness (dent and flint), commercial dent hybrids, dent corn heat-dried under various conditions, and a group that varied in starch composition (waxy, regular, high amylose) and protein, oil, and ash contents. Density, NIR, and APS values were highly, linearly, and positively correlated, provided homogenous groups were analyzed and evaluated. In samples that were highly susceptible to breakage, correlation coefficients of hardness determination increased if calculations were made on a basis of constant breakage susceptibility. The three methods of hardness determination were equally sensitive and useful in routine analyses.

Hardness (Texture) of Hard Red Winter Wheat Grown in a Soft Wheat Area and of Soft Red Winter Wheat Grown in a Hard Wheat Area.--Hardness (by three methods: time to grind, particle size index, and NIR) and protein were determined in soft and hard red winter wheats grown in Billings, Mont.; Atchison, Kans.; and Lafayette, Ind. and in hard red winter wheat cv. Newton grown at 13 locations in Kansas. There were large differences and no overlap in hardness between hard and soft wheats at each location and among all locations. However, times to grind of both hard and soft wheats were higher in soft wheat than in hard wheat producing areas. There was no significant correlation between protein content and hardness of the cv. Newton. Time to grind generally increased, indicating softening, in wheat grown in eastern parts of Kansas with progressively higher precipitation. The correlation between time to grind and average rainfall was significant at the 10% level. The three methods of hardness determination were correlated; the correlations were highest between particle size index and NIR. Correlations between hardness and protein content were either very low or insignificant.

Molds and Mycotoxins

In mycotoxin research, we develop analytical procedures, preferably suitable for use in grain-marketing channels; for detecting specific fungal components as measures of extent of invasion, mycotoxins, and other fungal metabolites; and for identifying fungi-grain interrelationships that may regulate

invasion of particular grain types, varieties, or hybrids by specific genera or species of fungi. The approach used in these studies is to apply optimized extraction and chromatographic techniques and to simplify and make more effective initial extraction, cleanup, and final detection steps. Metabolites are evaluated as measures of fungal invasion on grains and are compared with mycological and such other tests as discoloration, germination, fat acidity, and odors. We also investigate differences in susceptibility to invasion by fungi among grain types, varieties, or hybrids.

Mycotoxin Analysis of Scabby Wheat.--Analyses of wheat kernels heavily infected with Fusarium graminearum (the fungus that causes scab) showed that deoxynivalenol (DON) was the only known mycotoxin present. An improved method using automated high-pressure liquid chromatography was developed for determining DON. Analysis of wheat samples from elevators and individual fields in 1982 showed that scab was present in areas where wheat production was low--that is, eastern Kansas, eastern Nebraska, and parts of Iowa and Missouri. Some scab was found in the 1983 wheat crop, but its incidence was very low compared to the 1982 crop.

Processing Tests with Scabby Wheat.--Tests with hard and soft wheats were conducted in cooperation with the Department of Grain Science and Industry at Kansas State University and the USDA Soft Wheat Quality Laboratory at Wooster, Ohio. None of the cleaning operations tested completely removed scab from wheat, and, in some cases, DON content was lowered only slightly by cleaning. All fractions from milling of scab-infected soft and hard wheats contained DON. Straight-grade flour has slightly lower DON concentrations than the cleaned wheats, and offal fractions (bran, red dog, shorts) had significantly higher concentrations. Microscopic and chemical tests showed that degree of fungal infection varied considerably among kernels and that the fungus (Fusarium graminearum) can penetrate completely into a kernel. Baking of bread did not destroy DON.

Testing Toxicity of Scabby Wheat.--The toxicity of scabby wheat to swine was studied in collaboration with the Department of Animal Science and Industry at Kansas State University. Swine showed no signs of sickness from eating DON-contaminated diets, but they began refusing feed when DON exceeded about 1 ppm. No DON could be found in tissues of swine that were withdrawn from feed for 12 hours before slaughter.

Effects of Fungal Infection on Kernels from Scabby Wheat.--A variety of tests were conducted on scabby wheat to determine what damage was caused by the fungal infection. Hard red

winter wheat infected with the fungus was first visually graded into three categories based on kernel appearance; (1) normal, sound-appearing kernels of good color and weight, (2) lightly infected kernels of normal size but of light weight and color, and (3) heavily infected kernels that were shriveled and lightly colored. These three classes of scabby wheat were then analyzed using light and electron microscopy, histochemistry, polyacrylamide gel electrophoresis of storage proteins, germination tests, and plating of the fungus from infected kernels. The results of these tests revealed that the fungus is an extremely aggressive invader, destroying starch granules, storage proteins, and cell walls. The fungus showed a preference to aleurone and pericarp tissues, but hyphae were found throughout the entire starchy endosperm tissue. The germ seemed to be spared infection except in heavily invaded kernels; however, the lightly infected kernels with apparently intact germ exhibited reduced germination and vigor. Microscopic examination of germinating lightly infected kernels revealed extensive invasion of the scutellum and embryonic axis, indicating renewed fungal growth during inbibition. The results of this study suggest that a visual inspection of scabby wheat kernels can be used to estimate the degree of kernel infection.

Ergosterol; Ergosta-4,6,8(14),22-tetraen-3-one; Ergosterol Peroxide; and Chitin in Ergoty Barley, Rye, and Other Grasses.--Ergosterol, ergosta-4,6,8(14),22-tetraen-3-one (ETO), ergosterol peroxide (EP), and chitin contents in ergot sclerotia ranged from 204 to 827, 0.74 to 5.6, 41 to 152, and 8,210 to 9,020 µg/g, respectively, in barley, rye, and five grasses. Ergosterol and chitin contents of ergot sclerotia were high compared to ergot-free grain, and removal of ergot sclerotia from grain kernels leaves behind only background levels of ergosterol. Ergot contamination increased the ergosterol content significantly more than the chitin content of the grain. Maximum ergot contamination allowed by U.S. Grain Standards is 0.1% by weight in some grains (barley and oats) and 0.3% in others (rye and wheat). Only at or above the 0.3% allowed ergot level would increases in ergosterol contents become significant. Ergosterol, ETO, EP, and chitin are components of other fungi besides Claviceps spp.

The Biological Research Unit is concerned with fundamental and applied biology of insects and microorganisms that infest stored grains and cereal products. Insects and microorganisms are the principal kinds of organisms that adversely affect grain quality. Insect and microbial activity in stored grains decrease germinability, discolor part or all of the seeds or kernels, cause weight loss, reduce nutritional value, produce heat, and increase moisture. The latter two factors, in turn, bring about physical, chemical, and physiological changes in the grain. Some insects feed on whole grain, others on broken kernels, thereby increasing the percentage of broken kernels and dockage. Some microorganisms produce toxins that are injurious to man and to domestic animals. Grain and cereal products are subject to insect and microbial infestation, damage, and contamination while in the marketing channels. The Federal Government; food storage, transportation, and processing industries; and the consumer suffer large monetary losses from grain insects causing damage and downgrading and making the products unfit for human consumption. The presence of insects and the damage done by them affect us adversely in the highly competitive foreign market.

Another cause for concern in relation to foreign trade in grain is that pesticide and fumigant residues are receiving increasingly critical scrutiny in many parts of the world. These residues are also of concern for the domestic market. Urgently needed are more acceptable and effective methods for preventing insect damage and contamination during storage, handling, processing, packaging, transportation, and retail distribution. The need is critical for effective pesticides and application methods that can be used in our domestic and foreign markets without leaving objectionable residues. Even more desirable is the development of effective preventive and control measures using biological, physical, mechanical, or other nonchemical means that would reduce or completely eliminate the use of pesticidal chemicals.

The primary mission of the Biological Research Unit is to gain adequate knowledge of insects and microorganisms and their storage environment to develop appropriate techniques and methods of pest management under experimental and practical conditions. Research is divided into the following areas.

Insect Biochemistry and Physiology

Our goal is to understand the growth and development of insects in biochemical terms and to identify metabolic processes that are potential targets for new pest control agents. The program includes basic research in insect biochemistry, endocrinology, toxicology, and morphology and applied research in the development of biorational materials that inhibit specific aspects of the insect's physiological and behavioral development. Chemi-

cals receiving special attention are insect growth regulators that act as hormone mimics or antihormones and compounds that disrupt cuticle biochemistry.

Insect Growth Regulator Protected Wheat in Storage for 2 Years.--An insect growth regulator, phenoxycarb (ethyl p-phenoxyphenoxyethylarbamate), was effective as a grain protectant in the field. It controlled beetles and moths for over 2 years when mixed with wheat at 10 ppm. Maag Agrochemical is using the results to support the registration of phenoxycarb as a chemical protectant of stored grain.

New Regulatory Factors of Insect Molting Purified and Characterized.--β-N-Acetylglucosaminidases from insect tissues were characterized immunologically into three specific types of proteins: exo-β-N-acetylglucosaminidase, exochitinase, and endochitinase. Endochitinases that initiate the digestion of the structural polysaccharide chitin in insect cuticle were isolated and characterized. They are glycoproteins that cleave glycol chitin and chitooligosaccharides ultimately to disaccharide and trisaccharide. The enzymes play a critical role in metamorphosis and molting. We are now determining how enzymatic activity is regulated in vivo so that molting can occur. Several esterolytic enzymes were partially purified from molting fluid and characterized. Carboxylesterase, cholinesterase, arylesterase, and juvenile hormone esterase were identified. The enzymes probably hydrolyze esters found in hormones, lipids, and waxes during cuticle morphogenesis. The results are providing a better understanding of insect molting at the molecular level.

Several New Insect Neuropeptides Identified.-- In the brain of adult specimens of the tobacco hornworm moth, Manduca sexta (L.), cells immunoreactive for several kinds of neuropeptides were localized by means of the PAP procedure, by use of antisera raised against mammalian hormones or hormonal peptides. In contrast, no such neurosecretory cells were found in the corpora cardiaca and corpora allata (CC/CA); in the CC/CA, however, immunoreactive nerve fibers were observed, reaching these organs from the brain. The neurosecretory cells found in the brain were immunoreactive with at least one of the following mammalian antisera, namely those raised against the insulin B-chain, somatostatin, glucagon C-terminal, glucagon N--terminal, pancreatic polypeptide (PP), secretin, vasoactive intestinal polypeptide (VIP), glucose-dependent insulinotropic peptide (GIP), gastrin C-terminus, enkephalin, α- and β-endorphin, Substance P, and calcitonin. No cells were immunoreactive with antisera specific for detecting neurons containing the insulin A-chain, nerve growth factor, epidermal growth factor, insulin connecting peptide (C-peptide),

polypeptide YY (PYY), gastrin midportion (sequence 6-13), cholecystokinin (CCK) mid-portion (sequences 9-20 and 9-25), neurotensin C-terminus, bombesin, motilin, ACTH, or serotonin.

All the neuropeptide-immunoreactive cells observed emitted nerve fibers passing through the brain to the CC and in some cases also to the CA. In CC, these immunoreactive nerve fibers tended to accumulate near the aorta. It was speculated that neuropeptides are released into the circulating haemolymph and act as neurohormones.

Developmental Profiles and Electrochemical Properties of Insect Cuticle Tanning Metabolites Determined.--The concentrations of tyrosine and its storage molecules, β-D-glucopyranosyl-O-L-tyrosine (tyrosine glucoside), were correlated with developmental events during insect metamorphosis. The compounds are the initial substrates metabolized for cuticle sclerotization and pigmentation. Tyrosine glucoside first appeared in 2-day-old fifth-stadium larvae and reached maximum whole body titers in pharate pupae (2.5 mg/g). A rapid decline occurred shortly before larval-pupal ecdysis as the free tyrosine pool increased to peak titers at ecdysis (1.4 mg/g). Both tyrosine and tyrosine glucoside decreased to low levels (0.5 mg/g) as the pupal cuticle tanned. Tyrosine again increased in 1-day-old pupae and remained at high levels (1.5 mg/g) until the beginning of darkening of the pharate adult. Tyrosine glucoside remained at relatively low titers (0.05 mg/g) during pharate adult development. Both tyrosine and tyrosine glucoside increased slightly during adult eclosion and decreased to very low levels after adult tanning. Nearly all the tyrosine glucoside and two-thirds of the tyrosine occurred in the hemolymph where the concentrations during development paralleled those in whole body. Much lower amounts were present in fat body, integument, and gut.

The electrochemical properties of catecholamines that occur in the hemolymph and cuticle of insects during development were studied. The specific catecholamine utilized for tanning and the type of enzymatic oxidation appear to determine the kind of cuticle formed and its pigmentation. The cyclic voltametric behavior for dopamine, N-acetyldopamine (NADA), and N-β-alanyldopamine (NBAD) was similar except that the open chain o-quinones of the latter two compounds cyclized significantly more slowly than dopamine o-quinone. Tyrosinase from pharate pupal cuticle oxidized the three catecholamines, with NBAD and NADA being the preferred substrates. Oxidation to the corresponding o-quinone, indolization, and reoxidation to p-quinone imine was the pathway observed for both electrochemical and

enzyme catalyzed reactions. The results are providing a better understanding of cuticle morphogenesis and stabilization at the molecular level.

Insecticide Resistance in Insect Pests of Stored Grain

Research in the insecticide toxicology laboratory is designed to (1) monitor the extent and severity of insect resistance to insecticides currently in use on stored grain in the United States, (2) assess cross-resistance to candidate grain protectants with potential for registration and future use, (3) elucidate biochemical and genetic mechanisms for the most prevalent types of insecticide resistance, (4) screen novel classes of chemicals to reveal new types of candidate grain protectants, and (5) utilize structural rearrangements of the chromosomes of stored-product insects as tools in basic and applied studies of population biology and pest management.

Candidate Insecticide Synergists.--Three experimental substances UC-76212, UC-76214, and UC-76220 were evaluated as carbaryl synergists against the lesser grain borer (LGB), rice weevil (RW), and red flour beetle (RFB) by the filter-paper exposure method. Potency (minimum effective dose) as well as ceiling (maximum effect) were measured. All three experimental synergists were effective against the carbaryl-tolerant species (RW and RFB), but none were active against the carbaryl-sensitive species (LGB). The standard carbaryl synergist piperonyl butoxide was ineffective against all three species. The three experimental synergists were active against RW and RFB, even at doses ten-fold or more below the carbaryl dose. The relative potencies against RW (in decreasing order) were UC-76214 > UC-76220 > UC-76212. The greatest activity of any of the synergists was expressed by UC-76220 against RFB. This substance was an effective synergist, even at doses 1,000-fold below the carbaryl dose. UC-76212 was also highly potent against RFB, but, unlike UC-76220, it reached a plateau (ceiling) at >95% mortality. This plateau could be overcome by increasing carbaryl dosage. UC-76214 was much less potent than UC-76212 at low doses but did not differ significantly in ceiling.

Alleles of the Malathion Resistance Gene Resolved in the Red Flour Beetle.--Linkage analysis showed that the Rmal gene on chromosome 6 is responsible for all cases of malathion resistance tested in strains of the red flour beetle collected in Kansas, Iowa, Texas, North Carolina, and Georgia, as well as a strain from Nigeria. Bioassays and genetic tests revealed the presence of at least two alleles at the Rmal locus. One Rmal-1 is completely dominant, confers low-level resistance and is common in midwestern strains of the red flour beetle. Another, Rmal-2 is incompletely dominant, confers high-level resistance and occurs in strains collected in North Carolina

and Georgia. Modifying genes were found to have only a small effect on the expression of Rmal-2 and had no effect on degree of dominance of this allele.

Chromosome Rearrangements Isolated in the Red Flour Beetle.-- A tester strain homozygous for recessive markers on six different chromosomes was constructed and was found to be sufficiently viable for use in detecting chromosome rearrangements by pseudolinkage analysis. Adult red flour beetles were exposed to 4 krad of gamma irradiation, and male gametes were screened for the presence of induced chromosome rearrangements. Of 386 irradiated sperm cells tested, 187 contained partially sterilizing mutations that were inherited. Preliminary linkage analysis for 30 of the mutations showed that 5 involve either chromosome 4 or the Y chromosome. Such rearrangements are useful for basic studies on population biology, evolution, and speciation, and for applied studies on the genetic control of pest populations.

Metabolism and Fate of Stored-Grain Protectants

Research in this area is designed to maximize the persistence and efficacy of stored-grain protectants. We study the mode action of stored-grain protectants and the factors important in their degradation. Investigations focus on the effect of grain character, presence of foreign material in grain, and the infestation of grain with fungi. The interaction of stored-grain protectants with other grain additives such as oils used for dust suppression are also evaluated. Information on the movement and breakdown of these insecticides is useful in developing strategies to retard the development of insecticide resistance.

Effect of Wheat Class, Cultivar, and Protein Content on ^{14}C-Malathion Degradation.--The degradation of ^{14}C-malathion was studied in three representative cultivars from each of six classes of wheat. For each cultivar, a subsample containing either a relatively high or a relatively low protein content was included in the study. Winter white and club wheat had relatively high quantities of the chloroform extraction phase that had ^{14}C-malathion and its apolar degradation products. On the other hand, hard red spring and durum wheats contained relatively large quantities of unextractable residues that are generally formed under conditions favoring insecticide degradation. A different pattern of ^{14}C-malathion degradation was seen in hard red winter wheat, which contained relatively large quantities of ^{14}C-volatile compounds. Hard red winter was also the only wheat class that showed a difference between samples containing high or low protein levels. More significant correlation between wheat classes was seen when the various extraction phases were plotted against wheat protein content than against wheat moisture content. The correlation of the

various extraction phases with wheat protein content was most similar for durum, hard red winter, and hard red spring wheats.

Effect of Insecticide Distribution on ^{14}C-Malathion Metabolism.--The kernel to kernel movement of ^{14}C-malathion was examined when the same total amount of insecticide was applied to 5% or 100% of a wheat sample. Over the 50-day storage period, the levels of ^{14}C-malathion residues steadily decreased in the treated kernels and increased in the untreated kernels in the treatment receiving an uneven insecticide application. However, the treated kernels still contained over nine times the quantity of radiocarbon found in the untreated kernels. The relatively large differences in the residues found on individual kernels is significant, since previous studies indicated that there was no difference in the degradation of ^{14}C-malathion applied to 5% or 100% of a wheat sample.

Microbiology of Insect Pathogens

Many insect pests that infest stored grain and processed cereal products are susceptible to microbial insect pathogens such as certain bacteria, viruses, and fungi. These microorganisms are selective in their insect pathogenicity, do not pollute the environment, and are safe to humans and other mammals. Our research with these organisms involves basic and applied studies of the structure, physiology, and mode of action of selected bacterial and viral insect pathogens. These studies include the use of Bacillus thuringiensis and granulosis virus to control the Indianmeal moth and other lepidopteran pests of stored grains; structure, toxicity, and biosynthesis of the entomocidal protein of B. thuringiensis; use of insect tissue culture for in vitro determination of molecular toxicity; and measurement of differential toxicity between various B. thuringiensis isolates. Recent progress in this area includes the following.

Insecticidal Activity of Spore-Free Mutants of B. thuringiensis.--Three oligosporogenic mutants of B. thuringiensis (sporulation less than 0.1% of normal levels) were assayed for toxicity against larvae of the Indianmeal moth and the almond moth. The toxicity of the sporeless mutant preparations was significantly diminished against the Indianmeal moth but was fully active against the almond moth, based upon comparison with activity of B. thuringiensis standards against both insects. The toxicities of the mutant preparations toward the Indianmeal moth were consistent with the number of spores in the test samples, but spores did not contribute to toxicity to almond moth larvae.

Biochemistry of the Crystal Protein.-- The chemistry of entomocidal protein isolated from purified crystals of certain varieties of B. thuringiensis continues to be studied. When

solubilized by either of two standard methods (0.0135 N NaOH, pH 12.0; or in bicarbonate buffer, pH 10.5, containing a disulfide reducing agent), a single protoxin molecule (M-135,000) is released. The protoxin is a stable but inactive moiety that is susceptible to proteolysis from the C-terminus end of the peptide, creating in the process a smaller (68,000 M) and more stable and active peptide from the remaining N-terminal domain of the original protoxin. Endogenous protease activity or insect gut juice activity can liberate the active molecule, resulting in paralysis and eventual death of the insect larvae. A toxin similar in nature to the kurstaki variety described above, but toxic for mosquitos and flies, is produced by B. thuringiensis var. israelensis. Dissolution of the israelensis crystal protein follows a similar course, but the resultant protoxin is smaller and less distinct in size (about 70,000-80,000 M). It too undergoes an activation step catalyzed by protease, resulting in a smaller active moiety of 26,000 M. This toxin has an isoelectric point of approximately 4.6 but is not resistant to further proteolysis and will rapidly deteriorate if not purified.

Use of Cultured Insect Cells for Study of Toxins from B. thuringiensis.--Three different cell lines of the spruce budworm, one cell line each from the Indianmeal moth and the tobacco hornworm, and two cell lines from mosquitos were used to determine specificity of entomocidal toxicity between B. thuringiensis var. kurstaki and var. israelensis. In vivo, crystal protein from var. kurstaki was toxic only to lepidopteran larvae, and this pattern was conserved in vitro using cultured insect cells. But, the toxin from crystals of B. thuringiensis var. israelensis was primarily effective toward mosquito (dipteran) cells, yet it did possess slight activity toward lepidopteran cells. This pattern of activity is in complete agreement with sensitivity of larvae from the two insect orders to the two varieties of B. thuringiensis. Toxicity patterns of toxic protein from the two varieties are significantly different, indicating a potential diversity of mode of action between the two toxins. Lipid extracted from the susceptible tissue cell membrane caused a reduction of toxicity when preincubated with crystal protein prior to assay. The interaction with cellular membrane lipid may simply be an adsorption phenomenon or may signal the initiation of secondary effects within the membrane barrier.

Integrating Microbial Insecticides into Grain Protection Programs

Research in this area is directed toward developing methods for using microbial insect pathogens to prevent and control insect infestations in stored grains and processed products. Included are studies of the susceptibility of populations of Indianmeal moths and almond moths to B. thuringiensis, evalua-

tion of the effects of commodity characteristics, storage environment, and types of storage systems on pathogen persistence and effectiveness, and studies of interactions between biology and behavior of the pest insect species and method of pathogen application. Recent progress in this area includes the following.

Pilot-Testing Methods of Applying B. thuringiensis to Grain.--A 3-year pilot-testing program to evaluate the performance of B. thuringiensis under farm grain bin conditions in Nebraska, Kansas, Oklahoma, Iowa, and Illinois was concluded and a final report will be available soon. Application of Bt to the grain as it was augered into the bins produced much more uniform distribution than raking the formulation into the surface in already filled bins. Moth control was also slightly better with auger application. We observed no difference in efficacy between dust and wettable powder formulations, or between different water volumes used for the wettable powder formulation. Extensive laboratory tests have failed to demonstrate any reduction in efficacy that can be attributed to reduced water volumes, and reduced water volumes were much more easily handled in the field. Therefore, we are suggesting that a spray volume of 4 gal/500 ft^2 of surface area be recommended rather than the current 10 gal/500 ft^2.

Overall, during the 3 years of testing in wheat and corn, Indianmeal moth populations in the treated bins averaged about 50% of levels in untreated bins. However, this figure includes data from areas where populations were very erratic. In areas where infestations were present in most of the bins, populations were reduced 51% to 62% in wheat and 81% to 87% in corn.

Evaluation of Pest Management Strategies for Farm-Stored Grain

The onfarm capacity for grain storage has increased steadily during the past decade. U.S. grain producers faced with depressed grain prices have turned increasingly to storage of grain on the farm in anticipation of improved markets in the future. Currently, nearly two-thirds of the Nation's grain supply is owned by individual farmers and stored directly on the farm. The quality of this grain and the measures taken to maintain its quality are critically important to the U.S. position in world grain markets, to farmer income, and to consumer food costs. Research under this project develops storage systems and strategies for the management of grain stored on the farm and documents the specific value of individual components of the system in maintaining the quality of grain in storage and in preventing economic loss.

Pest Management Techniques Evaluated.--Studies are in progress in six farm bins filled with new harvest wheat to evaluate the effectiveness of various pest management techniques including screening, aeration, sealing, wall sprays, insecticide treatments during binning, and fumigation. The biological processes of insect invasion, development, and survival are being monitored in each bin and these data correlated with the various levels of pest management applied. Preliminary data show that over 40% of the grain insects detected in the bins during the first 4 months of storage were found in the bin in which no pest management steps were taken. In contrast, less than 4% of the insects were detected in the bin receiving the full range of management practices under study.

Pilot Study Approved.--A research study authorized under the Pilot Test Program will develop operational techniques required for the production and application of modified atmospheres for regulating insect populations in farm and country grain elevator storages. Standards of sealing required for retention of the atmospheres will be established and an economic assessment made on the feasibility of using this method of pest management in the commercial grain marketing system.

Insect Behavior and Ecology

Our goal is the quantitative, systematic investigation of factors that favor pest population survival, modify pest population growth, and determine the distribution of pests in marketing channels. Factors will include natural elements of the storage environment as well as chemical and biological control measures. These studies are a first step towards the rational development of integrated pest management systems. They provide information needed to develop predictive models that improve our capacity to make pest management decisions, to develop new options for integrated pest management, and to improve capabilities for early detection and subsequent monitoring and control of insect infestations. This research will initially emphasize onfarm storage but must ultimately be extended to treat the entire marketing system as a single unit.

Biology and Control of Fungi

Research is directed toward increasing our understanding of molds or fungi that grow and cause damage in grain. We monitor fungal population changes along with physical and chemical changes in grain during storage at various temperatures and moistures. These studies include tests of grain during low-temperature or solar-heated drying, as well as small-bin and laboratory scale storage tests. Other variables being investigated are initial inoculum or mold spore load, equilibrium moisture differences, and effects of mechanical damage. Preharvest fungal invasion of corn, as it affects quality and storability, is also studied.

Growth and Competition Among Species of Storage Fungi in Corn.--The Aspergillus glaucus group is the most commonly encountered group of storage fungi. In our tests, A. glaucus could grow in grain over a wider range of moisture content than any other species, although at high moisture contents other fungi seemed more competitive. In order of increasing moisture requirements, the fungi studied included A. glaucus and A. restrictus, A. candidus, Penicillium citrinum, A. ochraceus, A. niger, and A. flavus. In the environments tested, A. candidus appeared to be the most damaging species.

Equilibrium Moisture Contents of Various Grains.--Relative humidity or water activity is a more dependable predictor of fungal growth and spoilage than is grain moisture content. In actual practice, moisture content is the factor measured. We showed that corn may vary considerably in moisture content in equilibrium with a fixed relative humidity because of genetic differences and drying history. These differences were small for other grains. Among the cereal grains tested, wheat had the highest equilibrium moisture contents and rough rice the lowest. Corn and sorghum were intermediate. Compared to the cereal grains, soybeans had lower moisture contents below 70% or 75% RH and higher moistures above 80% or 85% RH.

Field Infection of Corn by Aspergillus flavus.--Extremely hot, dry growing conditions in 1983 resulted in higher than usual infection by A. flavus and the associated contamination with aflatoxin. Corn hybrids known to vary in their tolerance to drought stress appeared to be equally susceptible to A. flavus infection. As in previous years, infection could be most closely associated with insect damage. Insects and uncontrollable weather factors appear to be much more important than genetic differences in the corn in determining the extent of aflatoxin contamination.

Fungal Growth During Low-Temperature Corn Drying.--The 1983 corn crop near Manhattan, Kans. contained much higher than normal contamination by such fungi as Aspergillus flavus and A. niger. These fungi can grow quickly in shelled corn if moisture content is high and the temperature is warm. Corn with 20% moisture content was dried after harvest with solar-heated air or ambient air in round metal bins with drying floors. Considerable invasion by A. flavus and A. niger occurred in some of the corn even though the corn was essentially dry in 3-4 days. Two bins with 20% initial moisture had as many as 20%-40% of the kernels invaded by each of these fungi in the upper part of the bin. Two similar bins had only about 5% invasion under the same treatments. In most seasons, we could expect to dry 20% moisture in 4 days with little or no

detectable fungal growth. The results suggest that initial contamination before harvest can be a significant factor in determining safe storage and drying conditions for corn.

Researchers in the Engineering Research Unit conducted investigations on minimizing fuel energy required for grain drying, measuring and controlling dust from grain handling, and reducing damage to grain during handling. Recent progress in these areas is summarized below.

Minimizing Fuel Energy for Grain Drying

On Farm Inbin Drying of Wet Corn.--Two inbin grain-drying systems were tested for energy efficiency on test lots of newly harvested yellow shelled corn. A 21-ft-diameter bin located indoors was supplied with heat from ambient air by a fan. A second 18-ft-diameter bin located outside was supplied by a fan with ambient air and with air from a solar collector. Wet corn was filled to a depth of approximately 5 ft for each test lot. At the end of each period, the 21-ft-diameter bin was unloaded, and a new test lot of corn was transferred to the bin. In the 18-ft-diameter bin, each test lot was left in place after drying to produce three layers in the bin. The drying systems were operated concurrently until the surface corn samples were down to 15% moisture. Electrical energy input needed for each 1% of moisture removed from corn in the 18-ft-diameter bin was 11% more in the second layer than in the first layer, while the third layer required 86% more energy than the first layer. In contrast, the energy input needed from the transferred corn system not only saved fan operation time and energy, it also had the advantage of mixing the broken corn and foreign material, as well as breaking up the slow-to-dry area that would otherwise tend to develop molds.

Our research tests and commercial-grain-storage aeration studies have shown complete control of grain-heating problems while using a controlled grain aeration system.

We are making progress toward developing computerized systems that may eventually simplify and automate the prevention and control of grain storage and handling facilities. One objective of the study is to make it possible for operating personnel to handle daily operations. In a usual situation, an operator must examine the status of equipment to ascertain proper operations. When an anomaly is detected, the operator determines its severity and whether it is a situation that has been encountered before. If so, information needed to remedy the situation should already be available. If not, the operator must consult experts concerning the problem and how best to correct it. That level of expertise is what we plan to embody in a machine with computerized information and to employ in a grain handling facility.

Our research involves obtaining input from operators of grain handling facilities to build a knowledge base of their expertise and translate it into machine-usable form. Once this

idea becomes practical, it could affect design of future grain elevators, requiring the inclusion of proper test points applicable to the use of an computerized process.

Measuring and Controlling Dust From Grain Handling

Dust Explosion Research.--Three types of grain dust (corn, wheat, and grain sorghum) and cornstarch (used as a reference) were each divided into varying size fractions (6 to 11) utilizing air and sieve classifications. The particle size distribution and the composition (content of moisture, ash, protein, and starch and fiber) of each size fraction were determined. Dust particles consisting almost entirely of ash material were found to concentrate in specific air classified size fractions. The total external surface area, the total volume, and the coefficient of variability were calculated from the experimental particle size distribution for each size fraction by utilizing a piecewise log-normal approximation. These values were compared to those calculated from the least-squares-fitted log-normal approximation of the actual distribution.

An operability study was performed to identify the latent risks in a grain processing and handling facility. A methodology that had been devised to examine the design and operation safety of chemical plants was applied to the operation of grain processing and handling facilities. Possible causes and consequences of component failures or improper operating conditions in the bucket elevator subsystem were systematically identified, and corrective actions required to improve the safety of the subsystem were determined.

Many possible hazards contribute to grain dust explosions in elevators. Three main events leading to a grain elevator explosion are the occurrence of an ignition source, the presence of ignitable dust, and that of air. This study used the fuzzy-fault-tree analysis to focus on ignition sources as hazards. The fuzzy-fault-tree approach can take into account possibilities of the failures of components and subsystems in a grain elevator; such possibilities are routinely predicted by personnel engaged in grain handling. The possibility of failure is considered to be a fuzzy set defined on a numerical scale ranging from 0 to 1--that is, on [0,1]. It appears that the notion of the possibility of failure is much more predictive in outlook than that of the probability of failure. This fuzzy approach was applied to the fault tree of the occurrence of ignition sources in a typical grain elevator and produced reasonable results.

Dust Control.--A data acquisition system was used in the full-scale 3,000 bushels-per-hour USGMRL elevator to monitor dust emission levels of selected test grain lots. Dust

emission levels of newly harvested wet corn were approximately 1/10 of the emission levels from dry corn that had been handled repeatedly. One test lot of wheat, which had become heated as a result of insect development, showed an emission level that was twice as high as a similar lot without heating. In another test, the dust-control system was turned off for a period of 15 minutes. Dust emission level climbed slowly and steadily throughout the 15-minute period. When the dust control system was turned on, dust emission levels returned to normal within 2 minutes. Emissions were measured with light beams monitoring dust cloud opacity at boot and head pulley areas of the bucket elevator.

A 350 bushels-per-hour bucket elevator was used to compare three dust emission measurement methods of miniscale tests to a full-scale test. The methods included a high-volume air sampler, a light-beam monitoring dust-cloud opacitor, and the measurement of residual dustiness in grain samples. Grains tested were corn and wheat that had been treated with trace amounts of oil additives and controls with no treatment. All three methods measured similar concentrations in a range between 0.5 to 15 g/m^3 in the miniscale tests. Data from the full-scale test at a commercial elevator showed a range in dust emission measurements between 0.002 and 17 g/m^3. As a result of the analysis, we introduced a new method for rapid measurement of grain dustiness based on the analysis of residual dustiness in small grain samples.

Kernel density is a measureable characteristic in corn that is related to hardness. A study was conducted on seven newly harvested shelled corn lots to determine the effect of low-temperature slow drying on test weight, density, and void space. We developed a family of curves from the data that describe the effects of slow drying on a range of test weights, densities, and spaces. Drying increased both test weight and density, which caused a corresponding decrease in void space. Combined harvested lots that had damaged kernels had lower test weights but higher densities than hand-harvested, hand-shelled lots from the same field. In addition, whole kernels from a sample had lower densities than did broken kernels.

Reducing Damage to Grain During Handling

Two grain-velocity probes constructed at the USGMRL were used to measure the velocities of grain on a rotating disk and in a free-fall grain stream. Each probe consisted of two sets of light-emitting diodes (LED) and phototransistors (PT). By means of the cross-correlation method in conjunction with an oscilloscope signal from the PT, grain velocity was measured to an accuracy of 10%.

The flow rates of corn through round and square orifices were analyzed. Results indicated that the volumetric flow rate of corn can be expressed as a function of orifice size and moisture content. Bin-filling tests were conducted with corn and two different dropping heights and under chokeflow and spoutflow conditions in a 21-ft-diameter bin. Results showed that the distribution of fine material in the grain mass was more uniform for corn filled with the chokeflow method than that filled with the spoutflow method. A grainflow regulator and decelerator was designed and constructed at the USGMRL. The apparatus was used successfully to control the flow of grain into a bin. Results indicated that the distribution of fine material in grain that passed through the flow regulator was more uniform than that for grain transferred with a regular spout.

Computer Facilities

The computer facilities provide services and resources to all researchers at USGMRL. The present centralized facilities include two minicomputers with three terminals and various mass media storage devices. The older minicomputer is primarily used to gather data from nonstandard periphal devices, with the interface hardware designed and built at the facility, and assembly-level device drivers written to incorporate the device into the standard disk-operating system. The larger and newer minicomputer is available for researchers to carry out statistical analyses, data manipulation, graphing, and storing of large data bases. Each computer has CRT's (cathode ray tubes) for output with extensive, inhouse-developed graphical capabilities. These assembly-level graphical capabilities have been incorporated into high-level languages so that novices can easily use them. Any graph on the CRT can be reproduced in hard copies either by operator control or computer control. With the acquisition of more remote storage, a communication chassis and different software, it will soon be possible to provide remote terminals throughout the facility. Thus researchers will have computer capabilities in their laboratories or offices. Programming assistance is available for researchers, and many special-purpose programs have been written for various laboratory personnel. Several other minicomputers and microcomputers are used throughout the laboratory as integral parts of special machines or as small stand-alone units. Diagnosis of hardware problems and assistance in software application for these units are available.

Research activities in the Grain Quality and End-Use Properties Unit are concerned with (1) identifying physical and structural characteristics and chemical components that govern or are associated with functional properties; (2) developing, improving, and evaluating methods and instruments that can be used to objectively, rapidly, and accurately characterize and evaluate grain in domestic and export marketing channels; and (3) cooperating with plant breeders throughout the Great Plains and with agronomists, plant physiologists, entomologists, and biochemists at Kansas State University by providing milling, baking, and biochemical expertise and support for selective projects of mutual interest.

Specifically, researchers (1) Determine and evaluate the functional (milling and breadmaking) properties of early generation and potentially new hard winter wheats bred for the Great Plains and evaluate the earliest feasible generation of hard winter wheats bred for genetically high protein. Kjeldahl (protein) analytical equipment and the 10-g mixograph, together with micro- and macro-milling and breadmaking equipment, are employed to determine functional properties of about 1,600 plant breeders' samples (10 to 1,500 g). (2) Develop new methods and techniques of determining chemical, milling, breadmaking, physical-chemical, and biochemical properties of hard wheats. (3) Develop energy-conserving baking methods and high-protein and nutritionally improved breads. (4) Develop physical and biochemical fractionating and reconstituting techniques to relate functional (breadmaking) to biochemical properties of wheat-flour components and determine the chemical fractions and components of wheat responsible for quality differences.

After the flours are literally taken apart, corresponding gluten-protein, gliadin- and glutenin-protein and their fractions, modified and unmodified, and other wheat flour fractions of good and poor quality wheat flours are interchanged, one at a time and in combinations, in the reconstituted flours. Fractions and reconstituted flours are characterized by physical, biochemical, and breadmaking techniques. Research during the past year has been in the following areas.

Functional Properties of New Hard Winter Wheats

Of about 470 large samples milled (1,500 g each), 290 were agronomically promising new varieties and recent releases of hard winter wheats. They were characterized and evaluated in terms of their functional properties, including wheat hardness; bolting properties and flour yield; flour ash; dough mixing, oxidation, and water requirements; breadcrumb grain and color;

and loaf-volume potential. About 87% had good milling, chemical, breadmaking, and physical dough properties. Leading commercial wheat varieties are among them.

About 970 small samples (40 to 100 g) of early generation progenies of hard winter wheats were micromilled and evaluated for milling. We subjected each sample of flour to certain analytical, water-absorption, and mixogram tests. About 24% had promising overall functional properties.

Breadmaking Studies

Effect of Ascorbic Acid on Dough-Mixing Requirement (Point of Minimum Mobility).--Mixing time of straight dough (wheat-variety composites) increased with increasing amounts of ascorbic acid up to about 50 ppm and thereafter decreased. The increase in mixing time became greater as the mixing requirement of the flour increased. Bread volume of straight dough (wheat-station composites) increased to a maximum and then remained fairly constant with increasing amounts of ascorbic acid up to 1,000 ppm. Minimum amount of ascorbic acid required for maximum volume and optimum crumb grain increased as flour protein content increased.

Breadmaking Potential of Straight-Grade and Whole-Wheat Flours of 'Triumph' and 'Eagle-Plainsman V' Hard Red Winter Wheats.--'Eagle-Plainsman V' blend and 'Triumph 64' hard red winter wheats (13.1% protein) were chosen to represent varieties that possessed strong and mellow physical dough properties, respectively. Each was milled to provide straight-grade flour, bran, shorts, and red dog. Five blends of flour from each variety varied from straight-grade flour to 100% whole-wheat and were compared in optimized laboratory baking tests. Triumph 64's loaf-volume potential and ability to carry bran, shorts, and red dog were equal to those of 'Eagle-Plainsman V'. Coarse red and white brans and shorts were compared in breadmaking with those finely ground. Finely ground bran and shorts produced somewhat higher loaf volume than that for coarse bran and shorts. Breadcrumb grain for fine bran and shorts was better than that for the coarse components, and crumb grain for white bran and shorts was better than that for the red components. Crumb color was darker in bread made with finely ground red bran than that in bread made with coarse red bran and shorts, but crumb colors for the finely ground and coarse white brans and shorts were essentially equal. Reconstituted whole-wheat flours containing hard white winter wheat bran, shorts, and red dog produced substantially lighter breadcrumb colors than flours containing the feed components from hard red winter wheats.

The Use of Algae Dunaliella as a Protein Supplement in Bread.--Commercial preparations of the halotolerant and osmotolerant algae of the genus Dunaliella are unicellular green algae that produce large quantities of protein and glycerol and 3%-5% β-carotene and contain 25%-30% salt. The commercially available dried alga (alga 1), the alga from which the β-carotene had been removed (alga 2), and that from which β-carotene, glycerol, and salt had been removed (alga 3), together with their water-soluble and water-insoluble fractions, were evaluated for their gross composition and related functional properties when used as a protein supplement by blending with 90% wheat flour for white pan bread. Algae 1, 2, and 3 contained 24.5%, 25.6%, and 55.3% protein (N x 6.25, 14% moisture basis), respectively. Yields and protein contents of the water-soluble and water-insoluble fractions partly depended on the β-carotene, glycerol, and salt contents of each algal preparation. Gas productions of the 90:10 wheat flour and algae blends were only 7.4 and 5.1 gasograph units (GU) for algae 1 and 2, respectively, because of high salt levels. Gas productions for blends with the salt-free, water insolubles of algae 1 and 2, however, were satisfactory and approached the calculated value of 49.4 GU. The commercial conditions for the removal of β-carotene (alga 2) and glycerol and salt (alga 3) materially and adversely affected the loaf-volume potentials of the water-insoluble fractions of algae 2 and 3. After we extracted the water solubles (glycerol, salt, water-soluble protein, etc.) of alga 1, the contribution of its high-protein, water-insoluble fraction to loaf volume was essentially equal to that of the 10% of replaced wheat flour.

Analytical Methods

High Performance Liquid Chromatographic Separation of Peptides for Sequencing Studies.--HPLC has proven valuable in preparing, separating, and analyzing peptides for amino acid sequencing studies. The method is especially useful in instances where only small amounts of protein are available for sequencing. This section reports several ways we have used HPLC peptide separations while determining the amino acid sequences of thionin proteins isolated from diploid wheat relatives. HPLC was used to confirm the purity of the thionins prior to sequencing, to separate thionins from each other, and to monitor the progress of enzymatic protein hydrolysis reactions to ensure that hydrolysis was complete. The method was used to analyze the proteolytic peptide "fingerprints" of thionins from bread wheat and from wheat relatives, which gave a preliminary indication of which of the bread wheat thionins was most similar (or identical) to that isolated from the diploid relative. Finally, HPLC was used to separate enzymatic hydrolysates of purothionins into pure peptides that were collected for further analysis.

HPLC Analysis of Amino Acids at the Picomole Level.--A method was developed for analyzing the amino acid compositions of protein hydrolysates by high performance liquid chromatography (HPLC) in 51 minutes. The amino acids were detected by the fluorescence of their o-phthaldialdehyde (OPA) derivatives, and 10 picomoles of each of the commonly occurring α-amino acids could be reliably determined. The OPA derivatization method, which uses ethanethiol as the thiol reagent, yields amino acid derivatives that are more highly fluorescent than OPA/mercaptoethanol derivatives and are stable for at least 2-1/2 hours. The HPLC method gives a better separation than previously published methods. Amino acid analysis down to the 3-picomole level and problems associated with low-picomole-level analysis were studied.

Polyacrylamide Gel Electrophoresis: A Comparison of Temperatures (4°, 7°, 10°, and 21°C) and Lactate Buffers Systems (Sodium and Aluminum).--Wheat gliadin PAGE electrophoregrams were affected both by different gel temperatures (4°, 7°, 10°, and 21°C) that were held constant during electrophoresis and by changing the buffer system from aluminum lactate to sodium lactate. The effect of those variables on band resolution, band curvature, and electrophoresis time were determined. A method to optimize protein band resolution and to minimize the band curvature and electrophoresis time under the various conditions was developed. The best overall combination of band resolution and time was found at 7° to 10°C with aluminum lactate buffer for 6 1/2 hours.

New Releases

New 'Rose' Wheat.--'Rose' wheat, Triticum aestivum L., C.I. 17795, is a hard red winter cultivar developed and released by the South Dakota Agricultural Experiment Station. 'Rose' was derived from the cross 'Seu Seun'/'Denton 8'//'Westmont'/4/'Hume'/3/'NE63265' ('Seu Seun 27'/3/'Oro'/'Minhardi'/'Hope'/4/'Red Chief'/'Pawnee'//'Cheyenne'). Milling and breadmaking properties of 'Rose' are very good. It has medium-strong physical dough properties that include a medium-long bake mixing requirement and very good mixing tolerance. 'Rose' has greater loaf volume, stronger physical dough properties, and better overall functional properties than 'Scout 66'.

New Disomic Substitution Line and Five Translocation Lines of Winter Wheat Germplasm Resistant to Wheat Streak Mosaic Virus.--One disomic (DS) substitution line and five translocation (T) lines of winter wheat germplasm resistant to wheat streak mosaic virus are being maintained by South Dakota State University, Brookings, S.D. 57007, and are in the National Seed Storage Laboratory. The amounts of protein in seed and flour of T_a, T_c, T_d, and disomic f exceed those of 'Centurk' in 1977.

The amounts of flour protein of $\underline{T}_a$ and $\underline{DS}_f$, the highest of the group, were 1.6 percentage points greater than that of 'Centurk' (13.7%). Mixogram mixing time to the point of minimum mobility (optimum mixing time for breadmaking) was 2.75 minutes (medium) for $\underline{T}_a$, 3.75 minutes for $\underline{T}_d$, 3.5 min for disomic $\underline{f}$, and 3.75 minutes (medium-long) for Centurk. Good overall breadmaking properties for all would be predicted from their mixing times and other physical dough properties.

New 'Nell' Wheat.--'Nell', C.I. 17803, is a hard red winter wheat (T. aestivum L. em. Thell.) (Reg. No. 669) developed by the South Dakota Agricultural Experiment Station. It was derived from the cross 'Scout' sel/'Captain' obtained from John Schmidt, University of Nebraska. It has good milling and baking properties. Mixogram mixing time to the point of minimum mobility (optimum mixing time for breadmaking) was between 'Scout 66' and 'Centurk'.

National Economics Division

Research activity of this unit encompasses the economic evaluation of a wide range of subjects related to producing and marketing grain and grain products. General research areas include grain quality, production costs, storage, marketing margins, and transportation.

Main objectives of these economic evaluations are (1) to provide economic assessments of new technologies and approaches to grain production and marketing; (2) to analyze the efficiency of assembling, processing, and distributing grain and grain products; (3) to conduct supply-demand analyses; (4) to estimate costs of producing and marketing grains and grain products, including white pan bread; and (5) to provide quick analyses of current topics.

Basic to the research efforts of this group, headquartered in Washington, D.C., is the interdisciplinary approach and environment afforded by USGMRL. This unit works in close cooperation with USDA's ARS personnel as well as with personnel at KSU. Research during the past year has been in the following areas.

Economic Evaluation of Alternative Energy Sources

A national research project was undertaken by ERS to identify the types and volume of crop residues available for energy production. Research in the 10-State Great Plains Region was directed from the USGMRL. In addition to estimates of total available crop residues, 16 areas of high concentration were identified.

Research was also conducted on the economics of solar energy in agriculture. Primary research in this area was shifted from studies of solar grain drying to solar-heated swine-housing systems. Multiple-use solar collectors can be used for both space heating and grain drying with proper farmstead layout.

U.S. Barley Industry

Analyses are made of: supply and demand for barley; the barley marketing system; domestic marketing patterns; transportation modes; world production and trade; the barley pricing system; costs of production, storage and handling, and processing; and agricultural policies related to barley.

Evaluation of U.S. Agricultural Policy on Wheat Marketing Participants

The agricultural policies of two periods, the 1960's and the 1970's, are evaluated, using econometric models, to determine the impacts of policy changes on price uncertainty, on producer viability, and on marketing margins of the various participants in the U.S. wheat complex.

White Pan Bread Marketing Spreads

The National Economics Division is responsible for determining white pan bread marketing spreads. These spreads are a part of the Division's long-term effort to monitor the performance of the U.S. food marketing system. Quarterly reports are prepared at USGMRL for release in Washington, D.C.

VISITORS TO THE U.S. GRAIN MARKETING RESEARCH LABORATORY

The Grain Marketing Research Laboratory was host to hundreds of visitors during FY 1982. Our register listed guests from 33 States and the District of Columbia and from at least 50 foreign nations. They included educators, scientists, legislators, farmers, processors, and students; they came to discuss, to learn, to teach, to look, and to work; they were curious, pleased, surprised, and amazed; we trust they were not disappointed. We were more than pleased to have them come, for we firmly believe that everyone benefits from these interactions: our visitors--through acquisition of information regarding the laboratory, its facilities, and its activities--and we--through the broadening experience of contacts with individuals with differing background but similar interests.

Many visitors came in groups under the sponsorship of the Kansas Wheat Commission in cooperation with the U.S. Wheat Associates. The USDA Foreign Agricultural Service was also instrumental in arranging visits, as were the Kansas State University Department of Grain Science and Industry, Food and Feed Grain Institute, and the International Grains Program and the Group for Assistance on Systems Related to Grain After Harvest. Members of these groups had an abiding interest and concern in international trade in wheat and in the storage of wheat and other grains both in the United States and other countries, as well as in research in these areas. It is through these face-to-face contacts that our visitors gain firsthand knowledge of our past and current efforts, and we learn of the advances made and challenges facing them in their homelands. These visitors were from Central and South America, the Orient, Southeast Asia, the Near East, and the Maghreb countries and other African nations with which we have actual and potential grain trade ties.

We were also pleased to host scientists and students who attended scientific society meetings at the USGMRL, distinguished researchers who came to our Laboratory specifically to consult our scientists and discuss in depth subjects of mutual interest, farmers and growers with broad interests in production, marketing, and utilization of grain and millers, bakers, and allied trade personnel from private companies. Last, but by no means least, we welcomed individuals and groups representing the general public. We were more than happy to acquaint them with the objectives and functions of the Laboratory, in short, our role in the grain industry.

LIST OF PUBLICATIONS

Ahmed, A. E. In press. Evaluation of paddy rice sack storage system, Alexandria J. Agric. Res., Paper No. 749.

Ahmed, R. F., Hopkins, T. L., and Kramer, K. J. 1983. Tyrosine and tyrosine glucoside titres in whole animals and tissues during development of the tobacco hornworm, Manduca sexta (L.). Insect Biochem. 13:369-374.

_____ Hopkins, T. L., and Kramer, K. J. In press. Tyrosine glucoside hydrolase activity in tissues of Manduca sexta (L.): effect of 20-hydroxyecdysone. Insect Biochem.

Aldis, D. F., Martin, C. R., Lee, R. S. and Fan, L. T. 1983. Particulate systems technology and fundamentals. Hemisphere Publishing, Washington, D.C.

Anderegg, B. N. In press. Studies on the distribution and movement of ^{14}C-malathion in stored wheat. Proc. Intern'l. Working Conf. of Stored-Product Entomol., 3rd.

_____ and Madisen, L. J. 1983. Degradation of ^{14}C-malathion in stored corn and wheat inoculated with Aspergillus glaucus. J. Econ. Entomol. 76:733-736.

_____ and Madisen, L. J. 1983. Effect of dockage on the degradation of ^{14}C-malathion in stored wheat. J. Agric. Food Chem. 31:700-704.

_____ and Madisen, L. J. 1983. Effect of insecticide distribution and storage time on the metabolism of ^{14}C-malathion in stored wheat. J. Econ. Entomol. 76:1009-1013.

Aso, Y., Kramer, K. J., Hopkins, T. L., and Whetzel, S. Z. In press. Properties of tyrosinase and DOPA quinone imine conversion factor from pharate pupal cuticle of Manduca sexta. Insect Biochem.

Bechtel, D. B. 1983. Effects of fungal infection on kernels from scabby wheat. [Abstr.] Cereal Foods World 28:564.

_____ 1983. From the farm to the table--a transmission electron microscopic account of cereal structure and its relationship to end-use properties. In D. B. Bechtel, ed., New Frontiers in Food Microstructure, pp. 269-285. [Review article] American Assoc. Cereal Chemists, St. Paul, Minn.

_____ (ed.) 1983. New Frontiers in Food Microstructure. 395 pp. Amer. Assoc. Cereal Chemists, St. Paul, MN.

_____ Gaines, R. L., and Pomeranz, Y. 1983. A microscopic study of the development of the barley cementing layer that causes hull-caryopsis adherence. [Abstr.] Cereal Foods World 28:559.

_____ Mueller, D. D., and Bulla, L. A., Jr. In press. End-group mobility of iso-even branched chain fatty acids in Bacillus thuringiensis cytoplasmic membranes during growth and sporulation. J. Biol. Chem.

Beeman, R. W. In press. Avermectin for control of stored-product insect pests. Proc. Intern'l. Working Conf. of Stored-Product Entomol., 3rd.

_____ 1983. Inheritance and linkage of malathion resistance in the red flour beetle. J. Econ. Entomol. 76:737-740.

_____ 1983. Linkage analysis for genes affecting scale color, eye color and resistance to malathion in the Indianmeal moth J. Hered. 74:301-302.

_____ 1983. Section on new mutants. Tribolium Info. Bull. 23:79-80.

_____ and Schmidt, B. A. 1982. Biochemical and genetic aspects of malathion-specific resistance in the Indianmeal moth (Lepidoptera:Pyralidae). J. Econ. Entomol. 75:945-949.

_____ Speirs, W. E., and Schmidt, B. A. 1982. Malathion resistance in Indianmeal moths (Lepidoptera:Pyralidae) infesting stored corn and wheat in the north-central United States. J. Econ. Entomol. 75: 950-954.

Chang, C. S., Converse, H. H., and Lai, F. S. 1983. Flow rate of corn through orifices as affected by moisture content. Am. Soc. of Agr. Eng., St. Joseph, Mich. ASAE Paper No. 83-3523.

_____ Converse, H. H., and Martin, C. R. 1983. Bulk properties of grain as affected by self-propelled rotational type grain spreaders. Trans. ASAE 26(5): 1543-1550.

_____ and Martin, C. R. 1983. An apparatus for grain velocity measurement. Am. Soc. of Agr. Eng., St. Joseph, Mich. ASAE Paper No. 83-3524.

_____ and Martin, C. R. 1983. Rheological properties of grain dust. Trans. ASAE 26(4): 1249-1256.

Chung, O. K. In press. Food oils and their uses by Theodore J. Weiss. AVI, Westport, Conn. [Book review] Cereal Foods World.

_____ 1983. Protein-lipid-carbohydrate interactions in wheat and its milled products. Book of Abstracts. 186th ACS National Meeting, American Chemical Society, Washington, D.C., Agricultural and Food Chemistry Division., No. 20. [Abstr.]

_____ Hubbard, J. D., Shackelford, D. D., and Pomeranz, Y. 1983. Amino acid composition of triticales, their parental wheats and rye grains and milled flours. [Abstr.] Cereal Foods World 28:574.

_____ and Pomeranz, Y. 1983. Recent trends in usage of fats and oils as functional ingredients in the baking industry. J. Am. Oil Chem. Soc. 60:1848-1851. (Also appeared as abstract in J. Am. Oil Chem. Soc. 60:725-726 and to appear in Pharmacological Role of Lipids, J. J. Kabara, ed., AOCS Monograph, American Oil Chemists Society, Champaign, Ill.)

_____ and Pomeranz, Y. In press. Cereal protein quality: functional vs/and nutritional characteristics. In: J. W. Finley and D. T. Hopkins, eds., Digestibility of Proteins and Amino Acid Availability of Cereals and Oilseeds. American Association of Cereal Chemists, St. Paul, Minn.

_____ and Pomeranz, Y. 1983. Fats and oils as functional ingredients in the baking industry--nutritional value. In: J. J. Kabara, ed., Advances in Modern Human Nutrition. Vol. III. Pathotox Publishing, Park Forest South, Ill.

_____ Pomeranz, Y., and Jacobs, R. M. In press. Solvent solubility parameter and flour moisture effects on lipid extractability. J. Am. Oil Chem. Soc.

Converse, H. H., Chang, C. S., and Lai, F. S. 1983. Airflow resistance measurements during in-bin corn drying. Amer. Soc. Agr. Eng., St. Joseph, Mich. ASAE Paper No. 83-3013.

Corpuz, L. M., Paulsen, G. M., Heyne, E. G., and Finney, K. F. 1983. Reselection of hard red winter wheat cultivar Lancota for high grain protein content. Euphytica 32:607-615.

El-Salhy, M., Falkmer, S., Kramer, K. J., and Speirs, R. D. 1983. Immunocytochemical identification of VIP and related peptides in the nervous system of an adult lepidopteran insect, Manduca sexta (L.). [Abstr.] In First Intern'l. Symposium on Vasoactive Intestinal Peptide and Related Peptides, Brussels, Belgium, p. 47.

_____ Falkmer, S., Kramer, K. J., and Speirs, R. D. 1983. Immunohistochemical investigations of neurohormonal peptides in the brain, corpora cardiaca and corpora allata of the adult lepidopteran insect, Manduca sexta (L.). Cell Tissue Res. 232:295-317.

_____ Falkmer, S., Kramer, K. J., and Speirs, R. D. In press. Immunocytochemical evidence for the occurrence of insulin in the frontal ganglion of a lepidopteran insect, the tobacco hornworm moth, Manduca sexta (L.). Gen. Comp. Endocrinol.

Finney, K. F. In press. An optimized breadmaking method after 44 years. Cereal Chem.

_____ Pomeranz, Y., and Bruinsma, B. L. In press. The use of algae Dunaliella as a protein supplement in bread. Cereal Chem.

Fretzdorff, B., Bechtel, D. B., and Pomeranz, Y. 1983. Feinstruktur von Weizenmehlteig und Brot. Getreide Mehl Brot. 37:43-45.

Gaines, R. L., Bechtel, D. B, and Pomeranz, Y. 1983. A microscopic study of the development of the barley cementing layer that causes hull-caryopsis adherence. [Abstr.] Cereal Foods World 28:559.

Gerstenkorn, P., and Pomeranz, Y. 1983. Maisforschung in den USA. Bericht 2. Kornermais Tagung, pp. 3-6. Granum Verlag. Detmold, West Germany.

_____ and Pomeranz, Y. 1983. Maisforschung in den USA. Mais 11(3):22-23.

Hagstrum, D. B. In press. The population dynamics of stored-product insect pests. Proc. Intern'l. Working Conf. Stored-Product Entomol., 3rd.

Haliscak, J. P., and Beeman, R. W. 1983. Status of malathion resistance in five genera of beetles infesting farm-stored corn, wheat and oats in the United States. J. Econ. Entomol. 76:717-722.

Heid, W. G., Jr. 1982. Photovoltaics: technical progress and its future in agriculture. U.S. Dep. Agric. Econ. Res. Serv. ERS Staff Rep. AGES820707.

_____ and Cramer, G. 1983. Grain Marketing Economics. John Wiley & Sons, New York.

Johnson, D. E. In press. Selection for resistance to Bacillus thuringiensis δ-endotoxin in an insect cell line (Choristoneura fumiferana). Experientia.

_____ and Davidson, L. I. In press. Specificity of cultured insect tissue cells for bioassay of entomocidal protein from Bacillus thuringiensis. In Vitro.

_____ and McGaughey, W. H. In press. Insecticidal activity of spore-free mutants of Bacillus thuringiensis against the Indianmeal moth and almond moth. J. Invertebr. Pathol.

_____ and Peterson, R. E. 1983. Limitations of HPLC for the detection of β-exotoxin in culture filtrates of Bacillus thuringiensis. Eur. J. Appl. Microbiol. Biotechnol. 17:231-234.

Jones, B. L., Finney, K. F., and Lookhart, G. L. 1983. Physical and biochemical properties of wheat protein fractions obtained by ultra-centrifugation. Cereal Chem. 60:276-280.

_____ and Lookhart, G. L. 1983. HPLC separation of peptides for sequencing studies. [Abstr.] Cereal Foods World 28:553.

_____ Lookhart, G. L., Cooper, D. B., and Finney, K. F. 1982. Wheat cultivar identification by polyacrylamide gel electrophoresis of gliadin proteins. [Abstr.] Agronomy Abstracts, Annual Mtg. of Amer. Soc. of Agron., 74th, p. 134.

_____ and Mak, A. S. 1983. The amino-acid sequence of a purothionin from Triticum monococcum, a diploid wheat. Eur. J. Biochem. 133: 621-625.

Kaneshiro, T., Baker, F. L., and D. E. Johnson. 1983. Pleomorphism and acetylene-reducing activity of free-living rhizobia. J. Bacteriol. 153:1045-1050.

Koch, K. B., Behnke, K. C., Burroughs, R., Seitz, L. M., and Sauer, D. B. Deoxynivalenol levels in 1982 Kansas-grown wheat collected at country elevators. In Scab Disease and Deoxynivalenol in the 1982 Wheat Crop. Kans. Agric. Exp. Stn. Bull. Rep. Prog. 440, pp. 5-9.

Koga, D., Jilka, J., and Kramer, K. J. 1983. Insect endochitinases: glycoproteins from moulting fluid, integument and pupal haemolymph. Insect Biochem. 13:295-305.

_____ Jilka, J., Speirs, R. D., and Kramer, K. J. 1983. Immunological relationships between β-N-acetylglucosaminidases from the tobacco hornworm, Manduca sexta (L.). Insect Biochem. 13:407-410.

_____ and Kramer, K. J. 1983. Hydrolysis of glycol chitin by chitinolytic enzymes. Comp. Biochem. Physiol. 76B:291-293.

_____ Mai, M. S., and Kramer, K. J. 1983. Comparative biochemistry of insexo-β-N-acetylglucosaminidases: characterization of a third enzyme from pupal hemolymph of the tobacco hornworm, Manduca sexta (L). Comp. Biochem. Physiol. 74B:515-520.

Kramer, K. J. In press. Vertebrate hormones in insects. In G. A. Kerkut and L. I. Gilbert, eds., Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vol. 7. Endocrinology I. Pergamon Press, Oxford.

_____ Beeman, R. W., Morgan, T. D., Hopkins, T. L., Lookhart, G. L., Aso, Y., and Roseland, C. R. 1983. The biochemical basis for the black mutation in Tribolium castaneum. Tribolium Info. Bull. 23: 86-88.

_____ Dziadik-Turner, C., and Koga, D. In press. Chitin metabolism in insects. In G. A. Kerkut and L. I. Gilbert, eds., Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vol. 3. Integument, Respiration and Circulation. Pergamon Press, Oxford.

_____ Morgan, T. D., Hopkins, T. L., Roseland, C. R., and Beeman, R. W. 1983. Regulation of cuticle pigmentation in the red flour beetle, Tribolium castaneum. [Abstr.] Proc. Intern'l. Working Conf. on Stored-Product Entomol., 3rd, p. 12.

_____ Morgan, T. D., Hopkins, T. L., Roseland, C. R., Aso, Y., Beeman, R. W., and Lookhart, G. L. In press. Catecholamines and β-alanine in the red flour beetle, Tribolium castaneum. Roles in cuticle sclerotization and melanization. Insect Biochem.

_____ Morgan, T. D., Roseland, C. R., Hopkins, T. L., and Beeman, R. W. In press. Regulation of cuticle pigmentation and sclerotization in red and black strains of the red flour beetle, Tribolium castaneum. Proc. Intern'l. Working Conf. of Stored-Product Entomol., 3rd.

_____ Nuntnarumit, C., Aso, Y., Hawley, M. D., and Hopkins, T. L. 1983. Electrochemical and enzymatic oxidation of catecholamines involved in sclerotization and melanization of insect cuticle. Insect Biochem. 13:475-479.

Lai, F. S. 1983. Soybean oil/lecithin as a grain dust suppressant. Proc. of a roundtable discussion sponsored by the Amer. Soybean Assoc., July 19, 1983. The Amer. Soybean Assoc., St. Louis, Mo.

_____ Afework, S., and Pomeranz, Y. 1983. Determination of hardness of wheat by Culatti microhammer/Cutter mill. [Abstr.] Cereal Foods World 28:572.

_____ Aldis, D. F., Kameyama, Y., Sayama, H., and Fan, L. T. In press. Operability study of grain processing and handling facility. The Amer. Soc. Agric. Eng., St. Joseph, Mich.

_____ Garrett, D. W., and Fan, L. T. In press. Comparison of explosion characteristics between Hartmann apparatus and 0.19 m^3 spherical apparatus. AICHE J.

_____ Garrett, D. W., and Fan, L. T. In press. Study of the mechanism of a grain dust explosion as affected by particle size and composition of grain dust. Powder Technol.

_____ Miller, B. S., and Pomeranz, Y. In press. Equilibrium moisture content of grain dust. Cereal Chem.

_____ Pomeranz, Y., Afework, S., and Converse, H. H. 1983. Moisture distribution in corn. [Abstr.] Cereal Foods World 28:576.

Lamkin, W. M., Nelson, S. W., Miller, B. S., and Pomeranz, Y. 1983. Glutamic acid decarboxylase activity as a measure of percent germination for barley. Cereal Chem. 60:166-171.

Lee, R. S., Aldis, D. F., Lai, F. S., and Rousser, R. In press. A high-energy chemical ignitor for dust cloud ignition. In J. K. Beddow, ed., Particulate Systems Technology and Fundamentals, Hemisphere Publishing, Washington, D.C.

Leung, H. K., Magnuson, J. A., and Bruinsma, B. L. 1983. Water binding of wheat flour doughs and breads as studied by deuteron relaxation. J. Food Sci. 48:95-99.

Lookhart, G. L., and Jones, B. L. 1983. HPLC analysis of amino acids at the picomole level. [Abstr.] Cereal Foods World 28:553.

_____ Jones, B. L., Cooper, D. B., and Hall, S. B. 1982. A method for hydrolyzing and determining the amino acid compositions of picomole quantities of proteins in less than 3 hours. J. Biochem. Biophys. Methods 7:15-23.

_____ Jones, B. L., Walker, D. E., Hall, S. B., and Cooper, D. B. 1983. Computer-assisted method for identifying wheat cultivars from their gliadin electrophoregrams. Cereal Chem. 60:111-115.

Lu, P. W., Lillard, D. W., Seib, P. A., Kramer, K. J., and Liang, Y. T. In press. Synthesis of the 2-methyl ether of L-ascorbic acid: stability, vitamin activity and ^{13}C-NMR spectrum compared to the 1- and 3-methyl ethers. J. Agric. Food Chem.

McGaughey, W. H. 1983. Storage of cereal grains and their products. [Book review]. Food Technol. (Chicago) 37(3):115-116.

_____ 1983. Compatibility of Bacillus thuringiensis and Captan when used in a mixture for treating seed corn for moth control. J. Econ. Entomol. 76:897-898.

_____ and Lai, F. S. 1982. Biological and physical factors critical to grain quality. In Proc. Producer Grain Marketing Conf., pp. 19-35, U.S. Department of Agriculture, Extension Service.

Mai, M. S. and Kramer, K. J. 1982. Properties of esterases from pharate pupal molting fluid of the tobacco hornworm, Manduca sexta (L). Comp. Biochem. Physiol. 74B:769-773.

Martin, C. R., Aldis, D. F., and Lee, R. S. In press. "In situ" measurement of grain dust particle size distribution and concentration. Trans. ASAE.

Martin, T. J., Bockus, W. W., Browder, L. E., Finney, K. F., Hatchett, J. H., and Wetzel, D. L. 1983. Registration of 'Arkan' wheat. Crop Sci. 23:1221-1222.

Mathewson, P. R. 1982. Cereal α-amylase, AACC Method 22-06. Approved Methods of the American Association of Cereal Chemists. Final Approval, October 27, 1982. American Association of Cereal Chemists, St. Paul, Minn.

_____ and Pomeranz, Y. 1983. A new commercial instrument for colorimetric assay of alpha-amylase. Proc. World Cereal Bread Congr. Prog. Cereal Chem. Technol., 7th, 5A:513.

_____ and Seabourn, B. W. 1983. A new procedure for specific determination of β-amylase in cereals. J. Agric. Food Chem. 31:1322.

Miller, B. S., Pomeranz, Y., and Afework, S. In press. A note on the hardness (texture) of hard red winter wheat grown in a soft wheat area and of soft red winter wheat grown in a hard wheat area. Cereal Chem.

Monsivais, M., Hoseney, R. C., and Finney, K. F. 1983. The Pelshenke test and its value in estimating bread-making properties of hard winter wheats. Cereal Chem. 60:51-55.

Oehrtman, R., and Schnake, L. D. 1983. Marketing channels and storage. Chap. 3. In G. Cramer and W. G. Heid, Jr., eds., Grain Marketing Economics, John Wiley & Sons, New York.

Pollman, D. S., Koch, B. A., and Seitz, L. 1983. Effect of vomitoxin-contaminated wheat in swine diets. [Abstr.] J. Anim. Sci. 57 (suppl. 1):94.

Pomeranz, Y. 1982. Cereal science and technology at the turn of the decade. S. Afr. Food Rev. 9(2):38-40.

_____ 1982. Getreidestandards Heute und Morgen. Die Muhle und Mischfuttertechnik 119(46):674.

_____ 1982. Grain quality standards. Food Technol. New Zealand 17(3):9-17.

_____ 1982. New sources of fats and oils. [Book review] Cereal Foods World 27:609.

_____ 1982. Technology of industrial production of baked goods. [Book review] Cereal Foods World 27:533.

_____ (ed.). 1983. Advances in Cereal Science and Technology. Vol. VI. American Association of Cereal Chemists, St. Paul, Minn.

_____ (ed.). 1983. Post harvest losses in quality of food grains. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

_____ 1983. BBV Backwaren Handbuch (Handbook of baked goods), Vol. 4. [Book review] Cereal Foods World 27:262.

_____ 1983. Buckwheat: structure, composition, and utilization. Crit. Rev. Food Sci. Nutr. 19:213-258.

_____ In press. Cereal resources--limitations, challenges and potential. Proc. '84 Food World Congress. Buenos Aires, Argentina.

_____ 1983. Dictionary of cereal processing and cereal chemistry. [Book review] Cereal Foods World 38:210.

_____ 1983. Die Maisharte. Bericht 2. Kornermais Tagung, pp. 6-9. Granum Verlag, Detmold, West Germany.

_____ 1983. Die Maisharte. Die Muhle + Mischfuttertechnik 120(19):259-260.

_____ 1983. Einnzelne und universelle Standardbackversuche fur Brot in den USA. Getreide Mehl Brot. 37(11):341-343.

_____ 1983. Endospermstruktur des Korns und Verarbeitung-seigenschaften. Die Muhle + Mischfuttertechnik 120(1):1-3, (2):18-22.

_____ 1983. From the land of 200 breads and small baked goods. Cereal Foods World 28:387-390.

_____ 1983. Grain structure and end-use properties. Food Microstruct. 1:107-124. (Also appeared in Proc. World Cereal Bread Congr. Prog. Cereal Chem. Technol., 7th, 5A:19-48 and in Elelmezesi Ipar (Hungarian).

_____ 1983. Handbuch Sauerteig. [Book review] Cereal Foods World 28:307.

_____ 1983. Kennzeichnung und Behandlung von Mehl. Die Muhle + Mischfuttertechnik 120(20):273-276.

_____ 1983. Molecular approach to breadmaking: an update and new perspectives. Bakers Dig. 57(4):72-86.

_____ In press. Polar wheat flour lipids--what they can and what they cannot do in breadmaking. Proc. Lipidform: Fats (Lipids) in Baking and Extrusion. Goteborg, Sweden.

_____ 1983. Protein angereicherte Brote in den USA. Getreide Mehl Brot. 37(9):277-281. (Also appeared in Tagung Backerei-Technol. Ber. 33:11-18.)

_____ 1983. Qualitatsstandards fur Getreide-Heute und Morgen. Getreide Mehl Brot. 37:202-206. (Also appeared in Tagung Backerei-Technol. Ber. 33.)

_____ 1983. Seed proteins. [Book review] Cereal Foods World 28:470.

_____ 1983. Single, universal, bread baking test--why not? Proc. World Cereal and Bread Congr. Prog. Cereal Chem. Technol., 7th, 5A:685-690.

_____ In press. Taking wheat apart and putting it together. Periodica Polytechnica (Budapest). (Also to appear in Bakers Dig.)

_____ 1983. Third international symposium on pre-harvest sprouting in cereals. [Book review] Cereal Foods World 28:686.

_____ Bolling, H., Weipert, D., and Zwingelberg, H. In press. Evaluation of German wheat varieties with the mixograph. Muhle + Mischfuttertechnik.

_____ and Chung, O. K. 1983. Lipid-protein interactions: new findings and interpretations. Proc. World Cereal Bread Congr. Prog. in Cereal Chem. Technol., 7th, 5A:825-830.

_____ and Chung, O. K. 1983. Lipids in cereal products. In P. J. Barnes, ed., Lipids in Cereal Technology, Chap. 14, pp. 287-303. Academic Press, New York.

_____ and Dikeman, E. 1983. Note--Minerals and protein contents in hard red winter wheat flours. Cereal Chem. 60:80-82.

_____ El-Baya, A. W., Seibel, W., and Stephan, H. In Press. Toast bread from defatted wheat flour. Cereal Chem. (Also appeared as an abstract in Cereal Foods World 28:565-566.)

_____ Martin, C. R., Traylor, D. D., and Lai, F. S. In press. Corn hardness determination. Cereal Chem.

_____ Meyer, D., and Seibel, W. In press. Structures of wheat, wheat-rye, and rye breads. Getreide Mehl Brot.

_____ Meyer, D., and Seibel, W. 1983. Wheat, wheat-rye, and rye dough and bread studied by scanning electron microscopy. [Abstr.] Cereal Foods World 28:554.

_____ and Miller, B. S. 1983. Wheat hardness: its significance and determination. Proc. World Cereal Bread Congr. Prog. Cereal Chem. Technol., 7th, 5A:399-404.

_____ Seibel, W., Brummer, J. M., and Stephan, H. 1983. Backtechnische Wirkung von Ol und Fett in Gegenwart von Emulgatoren bei Hefegolockerten Backwaren. Getreide Mehl Brot. 37:372-376.

_____ Zwingelberg, H., and Bruinsma, B. L. In press. Quality of German wheats evaluated by American and German methods. Baker's Dig.

_____ Zwingelberg, H., and Weipert, D. 1983. Der Mixograph--eine Methode zur Beurteilung der Qualitat von deutschen Weizensorten. Muhle + Mischfuttertechnik 120:538-541.

Quinlan, J. K., and McGaughey, W. H. 1983. Fumigation of empty grain drying bins with chloropicrin, phosphine, and liquid fumigant mixtures. J. Econ. Entomol. 76:184-187.

Roseland, C. R., Beeman, R. W., Kramer, K. J., and Hopkins, T. L. 1983. Microinjection of amino acids in Tribolium. Tribolium Info. Bull. 23:132.

Sauer, D. B. 1983. Fungi in grain: their significance and control. In E. Moreno and M. Ramirez, eds., Memorias del coloquio internacional sobre conservation de semillas y granos almacenados, pp. 400-411, Instituto de Biologia, UNAM, Mexico.

Schnake, L. D. 1983. White pan bread marketing spreads methodology. U.S. Dep. Agric., ERS Staff Rep. AGES830224, 74 pp.

_____ 1983. Bread. Developments in farm to retail price spreads for food products in 1982. U.S. Dep. Agric., Agric. Economic Rep. 500.

_____ and Stevens, C. A., Jr. 1982. Inland grain elevator operating costs and capital requirements. Kans. Agric. Exp. Stn. Bull. 644, 26 pp.

_____ and Stuart, K. D. 1982. White pan bread marketing spreads. U.S. Dep. Agric. Wheat Outlook and Situation (November 1982), WS-262.

_____ and Stuart, K. D. 1983. White pan bread marketing spreads. U.S. Dep. Agric. Wheat Outlook and Situation (February 1983), WS-263.

_____ and Stuart, K. D. 1983. White pan bread marketing spreads. U.S. Dep. Agric. Wheat Outlook and Situation (May 1983), WS-264.

_____ and Stuart, K. D. 1983. White pan bread marketing spreads. U.S. Dep. Agric. Wheat Outlook and Situation (August 1983), WS-265.

Seitz, L. M. 1983. Determination of fungal metabolites in grains by high-pressure liquid chromatography. [Abstr.] Cereal Foods World 28:553.

_____ 1983. Determination of deoxynivalenol in wheat. In Scab Disease and Deoxynivalenol in the 1982 Wheat Crop. Kans. Agric. Exp. Stn. Bull. Rep. Prog. 440, p. 4.

_____ 1983. Deoxynivalenol analysis of Kansas wheat quality profile samples. In Scab Disease and Deoxynivalenol in the 1982 Wheat Crop. Kans. Agric. Exp. Stn. Bull. Rep. Prog. 440, pp. 10-12.

_____ In press. Alternaria metabolites. In V. Betina, ed., Mycotoxins: Production, Isolation, Separation and Purification, Chap. 20, Journal of Chromatography Library Series Book. Elsevier Publishing, Amsterdam, The Netherlands.

_____ Mohr, H. E., Burroughs, R., and Glueck, J. A. 1983. Preharvest fungal invasion in sorghum grain. Cereal Chem. 60:127-130.

_____ and Pomeranz, Y. 1983. Ergosterol, ergosta-4,6,8(14),22-tetraen-3-one, ergosterol peroxide and chitin in ergoty barley, rye and other grasses. J. Agric. Food Chem. 31:1036-1038.

Shogren, M. D., and Finney, K. F. In press. Reproducibility of 100 g bread volume as affected by correct-side, wrong-side or both sides break and shred. Cereal Chem.

_____ Finney, K. F., and Bruinsma, B. L. 1983. Effect of ascorbic acid on dough mixing requirement (point of minimum mobility). [Abstr.] Cereal Foods World 28:554.

Storey, C. L. 1983. Chemical and nonchemical control of stored product insects. In E. Moreno and M. Ramirez, (eds.), Memorias del coloquio internacional sobre: Conservacion de semillas y granos almacenados. Instituto de Biologia, Universidad Nacional Autonoma De Mexico, pp 338-350.

_____ and other members of the assessment team. In press. The biologic and economic assessment of carbon tetrachloride. Cooperative Impact Assessment Report of U.S. Department of Agriculture, State agriculture experiment stations, Cooperative Extension Service, and other State agencies. Environmental Protection Agency: Tech. Bull.

_____ Sauer, D. B., and Walker, D. 1983. Insect populations in wheat, corn and oats stored on the farm. J. Econ. Entomol. 76:5.

_____ and Walter, V. E. In press. Fumigation of farm stored grain. In H. Raney, ed., Integrated Pest Management for Stored Grain. University of Kentucky, Cooperative Extension Service.

Urban, J. E., and Bechtel, D. B. In press. Fine structure of succinate-swollen Rhizobium trifolii 0403. Appl. Environ. Microbiol.

Wells, D. G., Bonnemann, J. J., Gardner, W. S., Finney, K. F., Geise, H. A., and Stymiest, C. E. 1982. Registration of 'Rose' wheat. Crop Sci. 22:1265.

_____ Bonnemann, J. J., Gardner, W. S., Finney, K. F., Geise, H. A., and Stymiest, C. E. 1983. Registration of 'Nell' wheat. Crop Sci. 23:804.

_____ Kota, R. S., Sandhu, H. S., Gardner, W. S., and Finney, K. F. 1982. Registration of one disomic substitution line and five translocation lines of winter wheat germplasm resistant to wheat streak mosaic virus. Crop Sci. 22:1277-1278.

Williams, J. R., Heid, W. G., Jr., Murphy, J. P., and Robbins, F. V. 1983. Solar heating systems for swine housing: an economic appraisal. Kans. Agric. Exp. Stn. Bull. 645.

Yamazaki, W. T., Seitz, L. M., Mohr, H. M., and Clements, R. L. 1983. Distribution of deoxynivalenol in soft wheat mill streams. [Abstr.] Cereal Foods World 28:564.

INVITATIONAL PAPERS, TECHNICAL PRESENTATIONS, AND OTHER REPORTS

Aldis, D. F., Lee, R. S., Lai, F. S., and Fan, L. T. August 1-5, 1983. Pressure development in explosion of cornstarch, wheat flour and lycopodium dust clouds in a 20-liter spherical chamber. Presented at the Pacific Region Meeting of the Fine Particle Society, Honolulu, Hawaii.

Anderegg, B. N. April 20, 1982. Degradation of insecticides in the environment. Department of Entomology, Kansas State University, Manhattan, Kans.

_____ November 22, 1982. Metabolism of insecticides by higher plants. Department of Entomology, Kansas State University, Manhattan, Kans.

_____ November 30, 1982. Effect of Aspergillus glaucus on the metabolism of ^{14}C-malathion by stored wheat and corn. National meeting, Entomological Society of America. Toronto, Ontario.

_____ October 25, 1983. Studies on the distribution and movement of ^{14}C-malathion in stored wheat. Third International Working Conference on Stored-Product Entomology, Manhattan, Kans.

_____ November 11, 1983. Effect of environmental factors on the behavior and fate of insecticides. Seminar. Department of Entomology, Kansas State University, Manhattan, Kans.

Bechtel, D. B. October 20, 1983. Biological membranes and the freeze-etch freeze-fracture technique. Genetics, Developmental and Cell Biology Section Seminar, Division of Biology, Kansas State University, Manhattan, Kans.

Beeman, R. W. December 9-10, 1982. Insecticide resistance in storage insects. Fumigants and Pheromones Seminar, Purdue University, West Lafayette, Ind.

_____ February 24, 1983. Activity of UC 76212, UC 76214 and UC 76220 as carbaryl synergists against beetle pests of stored products. Progress report.

_____ April 11, 83. Insecticide resistance and the Tribolium model. Department of Biochemistry, Kansas State University, Manhattan, Kans.

_____ October 14, 1983. Genetic control of insecticide resistance. Department of Entomology, Kansas State University, Manhattan, Kans.

_____ October 25, 1983. Avermectin for control of stored-product insect pests. Third International Working Conference on Stored-Product Entomology, Manhattan, Kans.

_____ and Nanis, S. M. December 1, 1983. Genetics of malathion resistance in the red flour beetle, Tribolium castaneum. Annual Meeting, Entomological Society of America. Detroit, Mich.

Bruinsma, B. L., and Finney, K. F. October 26, 1982. Various oils, surfactants, and their blends as replacements for shortening in breadmaking. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

Chang, C. S., H. H. Converse, and F. S. Lai. December 13-16, 1983. Flow rate of corn through orifices as affected by moisture content. Winter Meeting, American Society of Agriculture Engineers, Chicago, Ill. ASAE paper No. 83-3523.

_____ and C. R. Martin. December 13-16, 1983. An apparatus for grain velocity measurement. Winter Meeting, American Society of Agriculture Engineers, Chicago, Ill. ASAE paper No. 83-3524.

Chung, O. K. August 28-September 2, 1983. Protein-lipid-carbohydrate interactions in wheat and its milled products. 185th Annual Meeting, American Chemical Society, Washington, D.C.

_____ September 10, 1983. Research activities at the USGMRL. Fall Meeting of the Kansas Section, Korean Scientists and Engineers Association in America, Manhattan, Kans.

_____ Goforth, D. R., Finney, K. F., and Pomeranz, Y. October 24-28, 1982. Extractability of lipids from poor and good breadmaking glutens. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

_____ Goforth, D. R., Finney, K. F., and Pomeranz, Y. October 24-28, 1982. Lipid extractability of cysteine-treated dough. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

_____ Hubbard, J. D., Shackelford, D. D., and Pomeranz, Y. October 30-November 3, 1983. Amino acid composition of triticales, their parental wheat and rye grains and milled flours. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ and Pomeranz, Y. May 8-12, 1983. Recent trends in usage of fats and oils as functional ingredients in the baking industry. 74th Annual Meeting, American Oil Chemists' Society, Chicago, Ill.

_____ and Pomeranz, Y. October 30-November 3, 1983. Cereal protein quality: functional vs/and nutritional characteristics. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

Converse, H. H. January 18, 1983. Grain research activity to meet the challenges of the market place. Agricultural Engineering Student Branch, Kansas State University, Manhattan, Kans.

_____ Lai, F. S., and Afework, S. W. March 11-12, 1983. Shelled-corn moisture content determination and variables. Mid Central ASAE Meeting, St. Joseph, Mo.

_____ Chang, C. S., and Lai, F. S. June 26-29, 1983. Airflow resistance measurements during in-bin corn drying. Summer Meeting, American Society of Agricultural Engineers. Bozeman, Mont., ASAE Paper No. 83-3013.

El-Salhy, M., Falkmer, S., Kramer, K. J., and Speirs, R. D. September 15, 1983. Immunocytochemical identification of VIP and related peptides in the nervous system of an adult lepidopteran insect, Manduca sexta (L.). Symposium on Vasoactive Intestinal Peptide, Brussels, Belgium.

Finney, K. F. October 27, 1982. An optimized breadmaking method after 43 years. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

_____ January 17, 1983. Inaugural address of a graduate program in Cereal Science at the University of Sonora, Hermosillo, Mexico.

Gaines, R. L., Bechtel, D. B., and Pomeranz, Y. October 30-November 3, 1983. A microscopic study of the development of the barley cementing layer that causes hull-caryopsis adherence. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

Hagstrum, D. W. October 25, 1983. The population dynamics of stored-product insect pests. Third International Working Conference Stored-Product Entomology, Manhattan, Kans.

Heid, W. G., Jr. October 18, 1983. Economics of solar energy systems. Great Plains Agricultural Council, Solar and Wind Energy Symposium, Lincoln, Nebr.

Johnson, D. E. October 21-23, 1982. Bioassay of Bacillus thuringiensis entomocidal toxins with cultured insect tissue. Missouri Valley Branch meeting, American Society for Microbiology, Lawrence, Kans.

_____ April 4, 1983. Cellular response to parasporal toxin from Bacillus thuringiensis. Department of Biochemistry, Kansas State University, Manhattan, Kans.

_____ June 5-10, 1983. Specificity of cultured insect tissue cells for bioassay of entomocidal protein from Bacillus thuringiensis. Sixth International Conference on Invertebrate Tissue Culture, St. Augustine, Fla.

_____ October 20-22, 1983. Insecticidal activity of spore-free mutants of Bacillus thuringiensis against the Indianmeal moth and almond moth. Missouri Valley Branch Meeting, American Society for Microbiology, Omaha, Nebr.

Jones, B. L., and Lookhart, G. L. October 25, 1982. A 3-hour method for hydrolyzing and determining the amino acid composition of sub-microgram amounts of cereal proteins and peptides. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

_____ October 13, 1983. Theory and methodology of protein electrophoresis. Seminar, Kansas State University, Manhattan, Kans.

_____ and Lookhart, G. L. October 31, 1983. HPLC separation of peptides for sequencing studies. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ November 8, 1983. Using purothionin amino acid sequences to study wheat evolution. Seminar, Barley Malting Lab, Madison, Wis.

_____ Lookhart, G. L., Cooper, D. B., and Finney, K. F. November 30, 1982. Wheat cultivar identification by polyacrylamide gel electrophoresis of gliadin proteins. 74th Annual Meeting of the American Society of Agronomy, Anaheim, Calif.

Kramer, K. J. October 14, 1982. Chitin metabolism in insects. Seminar. Department of Anatomy and Physiology, Kansas State University, Manhattan, Kans.

_____ October 7, 1983. Insect peptides: native, naturalized and otherwise. Seminar. Department of Entomology, Kansas State University, Manhattan, Kans.

_____ Morgan, T. D., Hopkins, T. L., Roseland, C. R., and Beeman, R. W. October 25, 1983. Regulation of cuticle pigmentation in the red flour beetle, Tribolium castaneum. Third International Working Conference on Stored-Product Entomology, Manhattan, Kans.

Lai, F. S. April 26, 1983. Prevention and Protection Against Dust Explosions. Presented at Seminar on Treatment of Troubles in Powder Operations and Safety, Nagoya, Japan.

_____ May 12, 1983. Recent research on grain dust explosion. Presented at the Department of Agricultural Engineering, Seoul, Korea.

_____ July 19, 1983. Soybean oil/lecithin as a grain dust suppressant. Presented at a roundtable discussion sponsored by the American Soybean Association.

_____ Afework, S., and Pomeranz, Y. October 30-November 3, 1983. Determination of hardness of wheat by Culatti Microhammer/Cutter mill. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ Pomeranz, Y., Afework, S., and Converse, H. H. October 30-November 3, 1983. Moisture determination in corn. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, MO.

Lamkin, W. M., and Pomeranz, Y. October 26, 1982. Gas chromatographic analysis of propionic acid added as a preservative to corn. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

Lewis, B., Lai, F. S., Lee, R. S., and Fan, L. T. August 1-5, 1983. Explosive power of selected grain dust in a 20-liter spherical explosion chamber. Presented at the Pacific Region Meeting of the Fine Particle Society, Honolulu, Hawaii.

Lookhart, G. L., Finney, K. F., and Bruinsma, B. L. October 28, 1982. Effect of environment- and genetic-related alterations of physical and functional properties of wheat grain on the stability of the gliadin proteins as detected by polyacrylamide gel electrophoresis (PAGE). 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

_____ October 1983. HPLC: introduction and speciality columns. Seminar, Kansas State University, Manhattan, Kans.

_____ and Jones, B. L. October 31, 1983. HPLC analysis of amino acids at the picomole level. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

Martin, C. R., and Lai, F. S. August 1-5, 1983. A rapid method to measure dustiness of granular materials. Presented at the Pacific Regional Meeting of the Fine Particle Society, Honolulu, Hawaii.

Mathewson, P. R., and Seabourn, B. W. November 3, 1983. A new method for specific determination of beta-amylase. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

McGaughey, W. H., and Lai, F. S. October 26-28, 1982. Biological and physical factors critical to grain quality. Producer Grain Marketing Conference, U.S. Department of Agriculture, Extension Service, St. Louis, Mo.

Pomeranz, Y. October 6, 1982. Grain standards--today and tomorrow. 32d Meeting, Milling Technology, Arbeitsgemeinschaft Getreide-forschung, Detmold, West Germany.

_____ October 14, 1982. What is new in cereal chemistry? TNO, Institute for Grain, Flour, and Bread. Wageningen, The Netherlands.

_____ November 8, 1982. Review of research activities of IATA and USGMRL. Valencia Association of Bakers, Valencia, Spain.

_____ November 9, 1982. What research and development can do for the baker. Valencia Association of Bakers, Valencia, Spain.

_____ November 10, 1982. Biochemistry of breadmaking. Instituto de Agroqimica y Tecnologia de Alimentos, Valencia, Spain.

_____ November 21-27, 1982. Visiting professor, Technical University Munich, Department of Food Chemistry, Garching, Bavaria, West Germany. Lectures of Recent Advances in Cereal Science and Technology:

1. Composition and quality of cereal grains
2. Philosophy of research in cereal science and technology

3. Biochemical aspects of breadmaking
4. Structure of cereal grains in relation to chemical composition and utilization
5. Structure of cereal grains in relation to chemical composition and utilization (University of Hohenheim, Institute of Plant Nutrition)
6. Bringing the laboratory into the field and the field into the laboratory (Technical University Munich, Freising-Weihenstephan, Department of Plant Breeding and Production)

_____ November 30-December 3, 1982. Visiting professor, Technical University Berlin, Department of Cereal Technology, Berlin, West Germany. Lectures of Recent Advances in Cereal Science and Technology:

1. History, production, and grain standards
2. Grain structure and composition
3. Grain storage and quality control
4. Biochemical aspects of breadmaking
5. Development of instrumentation for determination of grain hardness, sprout-damage, and rice milling
6. Research activities of the USGMRL
7. Philosophy and organization of research in cereal science and technology in the United States

_____ December 6-10, 1982. Visiting professor, University of Munster, Faculty of Chemistry, Institute of Food Chemistry, Munster, Westphalia. Lectures on Advances in Cereal Science and Technology:

1. Grain production and standards
2. Grain storage
3. Structure, composition, and utilization of cereals
4. Grain quality
5. Development of instrumentation for determination of grain hardness, sprout damage, and rice milling
6. Research activities of the USGMRL
7. Education for research in biological sciences in the United States
8. Biochemical aspects of breadmaking

_____ December 14, 1982. Biannual Meeting, Zito-Hleb '82, Novi Sad, Yugoslavia:

1. Grain structure and end-use properties
2. Biochemical aspects of breadmaking

_____ January 3, 1983. Life and agriculture in the Soviet Union and People's Republic of China. Technical University, Lemgo, West Germany.

_____ January 18, 1983. Evaluation of scientists in ARS-USDA. Federal Research Center of Cereal and Potato Processing, Detmold, West Germany.

_____ February 22-24, 1983. Technical University, Department of Biochemistry and Food Technology, Budapest, Hungary:

1. Structure, composition, and end-use properties of cereal grains
2. Philosophy of research in cereal science and technology

_____ March 8-9, 1983. Second Kornermais--Tagung, Detmold, West Germany:

1. Hardness of maize
2. Maize research in the United States

_____ March 16, 1983. Release of wheat varieties in the United States. Milling Research Committee, National Millers Federation, Wurzburg, West Germany.

_____ March 17-18, 1983. 33d Jugenheimtagung, Darmstadt, West Germany:

1. Agriculture and grain in the Soviet Union and the People's Republic of China
2. Characterization and treatment of flour in the United States

_____ March 21, 1983. Life and agriculture in the Soviet Union and People's Republic of China. Annual Meeting, Danish Cereal Society, Nyborg at Funen.

_____ April 11, 1983. Wheat lipids--what they can and what they cannot do in breadmaking. Scandinavian Forum for Lipid Research and Technology, Goteborg, Sweden.

_____ April 13, 1983. What's new in research on the biochemistry and functional properties of barley, rye, triticale, and wheat? Swalof Seed Association, Swalof, Sweden.

_____ April 14, 1983. Department of Food Chemistry, University of Lund, Lund, Sweden:

1. Relation between structure, composition, and end-use properties of cereal grains
2. Biochemistry of breadmaking
3. Philosophy of research in cereal science and technology

_____ May 18, 1983. Short Course--American Association of Cereal Chemists, St. Paul, Minn.:

1. Structure, chemical composition, and properties of cereal grains
2. Biochemical basis of breadmaking

_____ June 10, 1983. Flour supplementation. Short Course--Association of Operative Millers, Kansas State University, Manhattan, Kans.

_____ August 2, 1983. Flour supplementation. Short Course--International Grains Program, Kansas State University, Manhattan, Kans.

_____ September 20, 1983. Flour supplementation. Short Course--International Grains Program, Kansas State University, Manhattan, Kans.

_____ October 24, 1983. Dark, hard and vitreous wheat. Food Science Seminar Series, Kansas State University, Manhattan, Kans.

_____ El-Baya, W., Seibel, W., and Stephan, H. October 30-November 3, 1983. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ Meyer, D., and Seibel, W. October 30-November 3, 1983. Wheat, wheat-rye, and rye dough and bread studied by scanning electron microscopy. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ Seibel, W., Brummer, J. M., and Stephan, H. May 19, 1983. Backtechnische Wirkung von Ol and Fett in Gegenvart von Emulgatoren bei hefegelockesten Backwaren. 34th Getreide-chemikertagung, Detmold, West Germany.

Quinlan, J. K., and McGaughey, W. H. December 22, 1982. UC62246 and UC70480: results of preliminary laboratory testing as stored grain protectants. Progress Report.

Sauer, D. B. July 20, 1983. Moisture equilibration in blended grain. NC-151 Technical Workshop, St. Louis, Mo.

Schnake, L. D. September 15, 1983. Some observations from 1981-82 white pan bread marketing spreads. Technical Committee, Association of Operative Millers, Manhattan, Kans.

Seitz, L. M. December 2, 1982. Mycotoxins and other fungal metabolites in grains. Department of Plant Pathology Seminar, Kansas State University, Manhattan, Kans.

_____ January 12, 1983. USGMRL research on mycotoxins. ARS workshop on mycotoxins, Beltsville Agricultural Research Center, Beltsville, Md.

_____ January 13, 1983. USGMRL research on scabby wheat. Joint U.S. Department of Agriculture and Food and Drug Administration Workshop on Vomitoxin and Other Fusarium Toxins, Washington, D.C.

_____ January 20, 1983. Chemical and microbiological evaluations of grain quality. Department of Agricultural Engineering Seminar, Kansas State University, Manhattan, Kans.

_____ October 30-November 3, 1983. Determination of fungal metabolites in grains by high-pressure liquid chromatogrpahy. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

_____ and Pomeranz, Y. October 24-28, 1982. Ergosterol, ergosta-4,6,8(14),22-tetraen-3-one, ergosterol peroxide and chitin in ergoty barley, rye and grasses. 67th Annual Meeting, American Association of Cereal Chemists, San Antonio, Tex.

Storey, C. L. January 27, 1983. Insect problems in the grain marketing system. Symposium: Wheat Quality in Storage-Demand for Integrated Pest Management. National Hard Winter Wheat Quality Council, Kansas City, Mo.

Shogren, M. D., Finney, K. F., and Bruinsma, B. L. October 31, 1983. Effect of ascorbic acid on dough mixing requirement (point of minimum mobility). 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

Tanaka, H., Lai, F. S., Fan, L. T., and Toguchi, K. March 27-31, 1983. Fuzzy fault tree analysis and its application to the prevention of dust explosion. Presented at AICHE Spring National Meeting, Houston, Tex.

Yamazaki, W. T., Seitz, L. M., Mohr, H. E., and Clements, R. L. October 30-November 3, 1983. Distribution of deoxynivalenol in soft wheat mill streams. 68th Annual Meeting, American Association of Cereal Chemists, Kansas City, Mo.

SEMINARS PRESENTED AT THE U.S. GRAIN MARKETING RESEARCH LABORATORY

Aso, Y. March 2, 1983. Catecholamine and tanning in insect cuticle. U.S. Department of Agriculture, Agriculture Research Service, Biological Research Unit, U.S. Grain Marketing Research Laboratory, Manhattan, Kans.

Bekes, F. September 14, 1983. Lipid contents and compositions of Canadian wheats. Department of Biochemistry and Food Technology, Technical University of Budapest, Budapest, Hungary.

Bowers, J. February 23, 1983. Overview of foods and nutrition research. Department of Foods and Nutrition, Kansas State University, Manhattan, Kans.

Dunbar, J. March 17, 1983. Agriculture--Kansas vs. Kenya. Agricultural Experiment Station, Kansas State University, Manhattan, Kans.

Fairbanks, G. April 13, 1983. Grain harvesting machinery design problems. Department of Agricultural Engineering, Kansas State University, Manhattan, Kans.

Hagstrum, D. May 16, 1983. The biology of the parasite Bracon hebetor and the management of storage pests. U.S. Department of Agriculture, Agricultural Research Service, Insect Attractants, Behavior, and Basic Biology Research Laboratory, Gainesville, Fl.

Hoseney, R. January 19, 1983. Overmixing of dough. Department of Grain Science, Kansas State University, Manhattan, Kans.

Johnson, T. February 2, 1983. Regulation of cell division and tumorigenesis. Division of Biology, Kansas State University, Manhattan, Kans.

Johnson, W. March 9, 1983. Research Summary: College of Engineering. Engineering Experiment Station, Kansas State University, Manhattan, Kans.

Larson, G. January 26, 1983. Philippine Island agriculture mechanization. Department of Agricultural Engineering, Kansas State University, Manhattan, Kans.

MacGregor, A. October 25, 1983. An endogenous α-amylase inhibitor from barley kernels: purification and properties. Basic Barley Research, Grain Research Laboratory, Winnipeg, Manitoba.

Mills, R. April 27, 1983. Millet preservation and storage. Department of Entomology, Kansas State University, Manhattan, Kans.

Pomeranz, Y. May 11, 1983. Specialty bread--European style. U.S. Grain Marketing Research Laboratory, USDA, ARS, Manhattan, Kans.

Pursley, W. March 30, 1983. Sanitation education. American Institute of Baking, Manhattan, Kans.

Schenck-Hamlin, D. May 4, 1983. Locating scientific translation services. Farrell Library, Kansas State University, Manhattan, Kans.

Schnake, L. April 20, 1983. Economics of grain handling facilities. U.S. Department of Agriculture, Economic Research Service, U.S. Grain Marketing Research Laboratory, Manhattan, Kans.

Wright, V. April 6, 1983. A new grain storage problem for Africa: Prostephanus truncatus. Department of Entomology, Kansas State University, Manhattan, Kans.

Yamazaki, W. January 12, 1983. Soft wheat--a major crop. U.S. Department of Agriculture, Agricultural Research Service, U.S. Grain Marketing Research Laboratory, Manhattan, Kans.

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*In cooperation with the Kansas Agricultural Experiment Station, Manhattan.